List No. 42.

PHYSICAL INSTRUMENTS

THE
CAMBRIDGE
SCIENTIFIC INSTRUMENT CO., LTD.
CAMBRIDGE, ENGLAND.

TELEGRAPHIC AND CABLE ADDRESS:
"INSTRUMENT, CAMBRIDGE."

TELEPHONE:
CAMBRIDGE, NO. 6.

1906

Gold Medal, International Inventions Exhibition, 1885.

Grand Prix, Paris Exhibition, 1900.

Two Grand Prizes, St Louis Exposition, 1904.

We also publish the following Catalogues which will be sent post free on application:—

Technical Thermometry.

Electrical Instruments. (New Edition in preparation.)

Duddell Patent Oscillograph.

Duddell Patent Thermo-galvanometer.

Grassot Fluxmeter.

Dolezalek Electrometer.

Rosenhain Calorimeter.

Standard Cadmium Cells.

Microtomes and Accessories, etc.

DIRECTIONS FOR FILLING ORDERS, ETC.

We shall be glad to send any of our apparatus to the National Physical Laboratory at Teddington, Middlesex, for Standardization. A small charge will be made for the carriage of the instruments to and from the Laboratory, but the actual verification fees will be charged at cost price.

Foreign orders must be accompanied by either a remittance or instructions for payment in London, on delivery of bills of lading, &c.

Cheques to be drawn payable to "The Cambridge Scientific Instrument Co., Limited," and crossed "London and County Bank, Cambridge."

Delivery. All prices quoted in this list are free on rails, Cambridge, and goods are sent carriage forward at consignee's risk. The full invoice price is allowed for returned packing cases, when actually received, in good condition, carriage paid, within fourteen days from delivery.

The greatest care is exercised in packing, but we cannot hold ourselves responsible for breakages in transit. In the event of any damage occurring, application should at once be made to the railway company or carrier.

Previous lists are hereby cancelled. Designs, materials and prices are subject to alteration without notice.

Trunk Line Telephone: "Cambridge, No. 6."

A B C Code, 5th Edition, and Western Union Code used.

Telegraphic and Cable Address: "Instrument, Cambridge."

All Correspondence should be addressed

The Instrument Company,

Cambridge,

England.

Note. The Works of the Company are off the Chesterton Road, just opposite Jesus Lock.

August, 1906.

Telegraphic Address "INSTRUMENT, CAMBRIDGE."

TELEGRAPHIC CODE.

For general purposes the A B C Code Book, Eden Fisher & Co., 5th edition, 1901, and Western Union Code are used. The following code words have been specially selected for this list.

What is the price of	*Gaban.*
What is the price, time of delivery and best terms for	*Gabardine.*
Quote price f. o. b. London of	*Gabionage.*
How soon could you deliver?	*Gaelic.*
Have you in Stock?	*Gainage.*
Must be delivered by	*Gainsayers.*
Could deliver the order in	*Gainstand.*
We could deliver in one month from receipt of order	*Gainstrive.*
We could deliver in two months from receipt of order	*Galangal.*
We could deliver in months from receipt of order	*Galeated.*
We have the instruments in Stock	*Galeopois.*
We have none of the order in Stock	*Gallant.*
We have part of the order in Stock, delivery of whole amount on	*Galleas.*
Order received	*Gallinule.*
Order has not been received	*Gallnut.*
Add to our order of	*Gracecup.*
Please deliver at once the following apparatus, we are writing by this mail	*Galoche.*
We have not heard from you in reply to our letter of	*Gamagrass.*
Wait our next letter before doing anything further	*Gambrel.*
Waiting your further instructions regarding	*Gambroon.*
What you suggest will do quite well	*Gamekeeper.*
We cannot understand what you mean, send full particulars	*Gammoning.*
We are sending full particulars by this mail	*Gangliform.*
Extra expense will be	*Gangtooth.*
Letter received	*Gangweek.*
Reply by cable	*Gardenplot.*
Kindly refer us to your bankers or agents for payment	*Gardenware.*
How were goods sent?	*Garfish.*
When did goods leave?	*Gargoyle.*
We will ship by	*Garnier.*
Goods have been duly received	*Garrotting.*
Ship by Grande Vitesse	*Gaseous.*
Ship by Petite Vitesse	*Gaslight.*
Ship care of	*Gasmain.*
If goods have not left, await our next letter	*Gasoscope.*
Goods have arrived damaged, please inform carriers	*Gasretort.*
Insure for amount of Invoice	*Gastric.*
Shall we insure goods to your order?	*Gateman.*
Please send a copy of your latest catalogue	*Gatherable.*

TABLE OF DATES.

To obtain the code-word for any particular date, add the word for the month to the word for the date, thus the 16th March = *nameless.*

Date	Code-word	Date	Code-word	Date	Code-word
First	*Mad*	Twelfth	*Mine*	Twenty-second	*Odd*
Second	*Main*	Thirteenth	*Moss*	Twenty-third	*Oil*
Third	*Make*	Fourteenth	*Mount*	Twenty-fourth	*One*
Fourth	*Mail*	Fifteenth	*Mull*	Twenty-fifth	*Otter*
Fifth	*Man*	Sixteenth	*Name*	Twenty-sixth	*Out*
Sixth	*Map*	Seventeenth	*Near*	Twenty-seventh	*Pack*
Seventh	*Mar*	Eighteenth	*Neat*	Twenty-eighth	*Page*
Eighth	*Mat*	Nineteenth	*New*	Twenty-ninth	*Pick*
Ninth	*Meet*	Twentieth	*Night*	Thirtieth	*Pin*
Tenth	*Mid*	Twenty-first	*Noon*	Thirty-first	*Pill*
Eleventh	*Milk*				

Month	Code-word	Month	Code-word	Month	Code-word
January	*Dust*	May	*Peg*	September	*Stone*
February	*Head*	June	*Rice*	October	*Town*
March	*Less*	July	*Root*	November	*Wards*
April	*Ling*	August	*Star*	December	*Well*

PREFACE.

THIS list includes most of the Physical Instruments, other than Electrical Instruments and Thermometers, which we are regularly making at the present time. The prices of a large number of instruments in the list have been greatly reduced; especially in § 4, Mechanics. A schedule of the other lists which we publish is given on the inner page of the front cover.

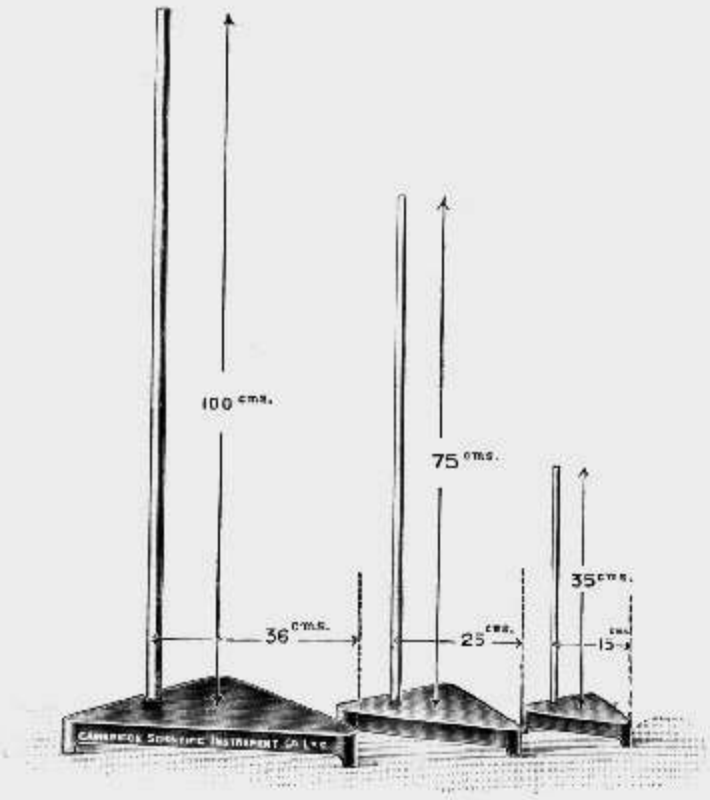
It may be pointed out, moreover, that the regular types of instruments catalogued in these various lists represent only a portion of our output. We are constantly called upon to construct special instruments and apparatus for research in laboratory and observatory, for investigating and controlling industrial operations, and for educational purposes. In many cases we have also furnished the designs for special instruments. A few examples are described in the last section of this list.

CONTENTS.

§ 1. GENERAL LABORATORY EQUIPMENT.

1001. Apparatus Cabinets, of the highest quality, made to order only. Estimates will be given on specification of requirements.

1002. Laboratory Stands, in three sizes (see illustration). We have felt for some long time that the stands in general use in the majority of Laboratories are far too weak and lacking in rigidity. We have therefore designed a series of stands and clamps which will firmly support a considerable weight at fairly large distances from the centre of support. The bases are drilled and countersunk, so that they can be screwed down if desired. For clamps see No. 1003.



No. 1002. $\frac{1}{5}$ full size.

	Diam. of Pillar	Height of Pillar	Price	¶	Code Word
1002 a.	$\frac{3}{8}$″ (10 mm.)	35 cm.	**3s. 9d.**	**0.90** *d*	*Import*
1002 b.	$\frac{5}{8}$″ (16 mm.)	75 cm.	**6s. 6d.**	**1.60** *d*	*Impost*
1002 c.	1″ (25 mm.)	100 cm.	**9s. 6d.**	**2.30** *d*	*Impress*

Longer pillars can be fitted at a small additional cost.

1003. Laboratory Stand Fittings, for use with laboratory stands Nos. 1002, b and c (see illustrations).

A. **Pillar block,** for clamping upon the pillar; drilled with three mutually perpendicular holes with set-screws for holding clamps, etc. ... ... **4s. 6d.** **$1.10** *d* *Incide*

B. **Connector,** drilled with three holes (two parallel, the third perpendicular to them), for use especially with the plain lengths of rod (E and F), and enabling any of the clamps, etc. belonging to this set to be held firmly at any inclination. These connectors are also useful for clamping two lengths of rod together so as to form practically one long piece.
3s. 0d. **$0.75** *d* *Incise*

C. **Vee-bracket,** for holding firmly, but without undue strain, a telescope or any such instrument as requires to be sighted in a definite direction. **4s. 6d.** **$1.10** *d* *Inclip*

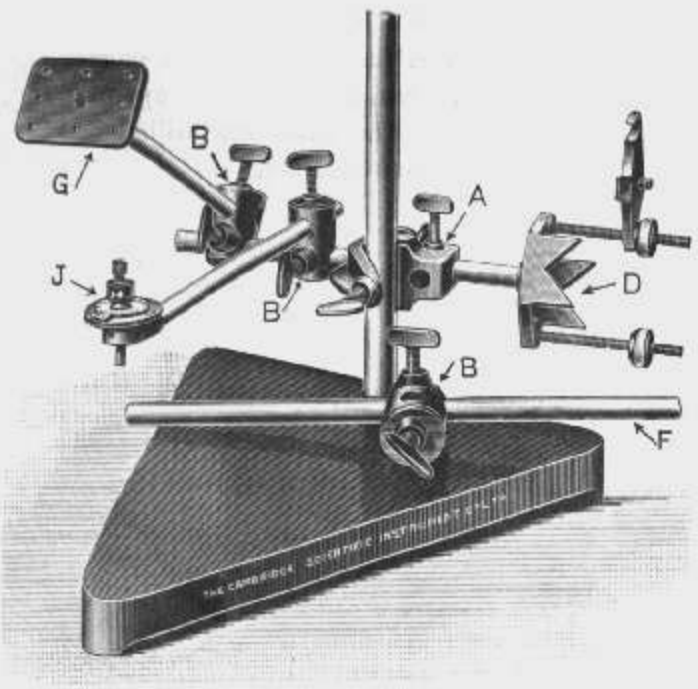
D. **Clamp,** for holding firmly at any inclination pieces from 60 mm. diameter down to nothing ... ... **6s. 6d.** **$1.60** *d* *Incog*

E. **Plain rod,** 200 mm. long ... ... **6d.** $0.12 *d* *Income*

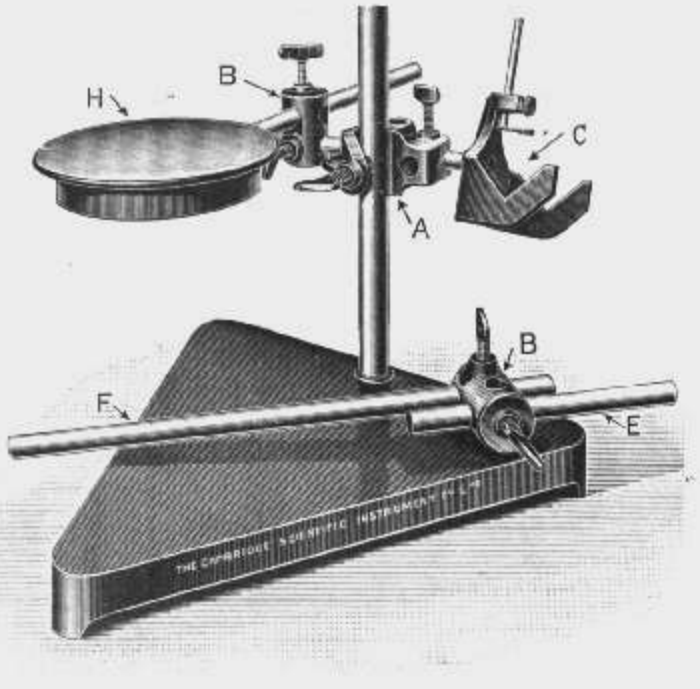
F. **Plain rod,** 400 mm. long .. .. **1s. 0d.** $0.24 *d* *Indart*

G. **Face plate,** drilled and countersunk so that a board or other woodwork may be screwed to it. In setting up apparatus for temporary use, this fitting is often highly convenient.

1s. 9d. $0.40 *d* *Indear*



No. 1003. ¼ full size.



No. 1003. ¼ full size.

H. **Flat circular iron table,** 180 mm. in diameter **3s. 0d.** $0.75 *d* *Indeed*

J. **Torsion head,** with circle divided into 10 degree divisions.

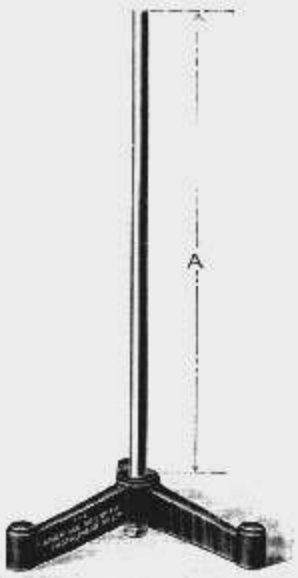
16s. 6d. $4.00 *d* *Indict*

1004. Adjustable pillar stand. This is similar to No. 1002 A, but with the addition of a screw by means of which the vertical rod can be rotated, so that the scribing styles of two or more instruments can be simultaneously brought into contact with a recording drum. If the drum is moving quickly, this arrangement is often most convenient.

18s. 0d. $4.40 *d* *Adipous*

1005. Simple form of the above with adjusting lever in place of screw.

7s. 0d. $1.70 *d* *Adjugate*

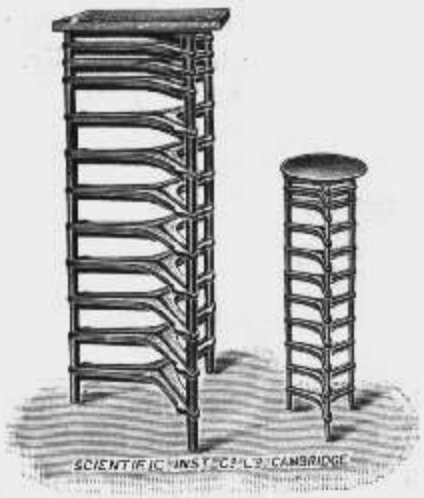


No. 1005 *a*. ¼ full size.

1005 a. Tripod pillar stand, as illustrated. The pillar is ⅝″ (16 mm.) in diameter, its length (A) being 38 cm. Similar stands of other dimensions can be supplied to order.

4s. 6d. $1.08 *d* *Ligure*

Geometric tripod stands. These stands, designed by Mr C. V. Boys, F.R.S., are especially adapted for supporting pieces of apparatus, such as galvanometers, lamps, &c. By their means a stand of any desired height may be made, each tripod making geometric contact with the one immediately below it. A triangular groove is formed on the upper surface of the tripods into which the levelling screws of an instrument may be placed. The stands are supplied in two sizes:—



Nos. 1006 *a*, 1006 *b*. $\frac{1}{10}$ full size.

1006 a. Small Size: Distance from centre of tripod to centres of feet 75 mm.

A set of 1 dozen consists of:—

9 stands, 75 mm. high,
2 stands, 25 mm. high,
and 1 stand, 25 mm. high, to which a metal table 155 mm. in diameter is fixed.

In Iron, per set of 1 doz.	**12s. 6d.**	**$3.00** *d*	*Caninal*
In Brass, per set of 1 doz.	**£1. 7s. 6d.**	**$6.70** *c*	*Awltree*

1006 b. Large size: Distance from centre of tripod to centres of feet 175 mm.

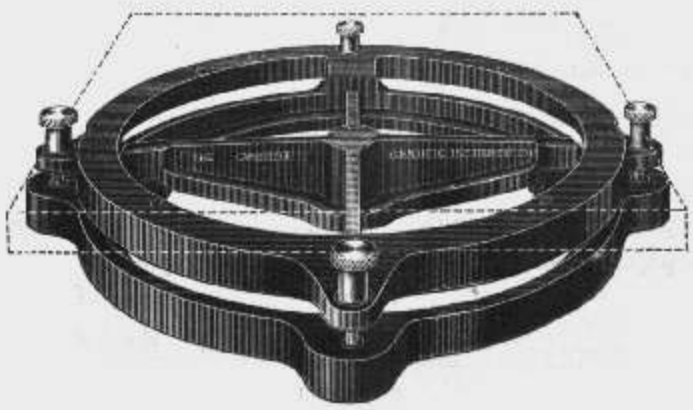
A set of 1 dozen consists of:—

9 stands, 76 mm. high,
2 stands, 36 mm. high,
and 1 stand, 36 mm. high, to which a wooden table 33 cm. square is fixed.

In Iron, per set of 1 doz.	**£2. 0s. 0d.**	**$9.75** *d*	*Canonistic*
In Brass, per set of 1 doz. ...	**£5. 10s. 0d.**	**$26.80** *c*	*Awlwort*

1007. Burton's levelling stand, of geometric design (see illustration). This rests upon three solid toes, either on a table or on a pile of Boys' geometric tripod stands (large size, see No. 1006 *b*). A gimbal construction provides for **independent** levelling adjustment about two **mutually perpendicular axes**. The adjusting screws, being independent of the toes on which the apparatus stands, can be set with the greatest freedom and delicacy, side-shake of the mahogany top being entirely absent. The advantage possessed by this construction over the ordinary arrangement of three foot-screws for levelling will be readily apparent; since any looseness in such foot-screws involves a corresponding side-shake in the table; so that closely-fitting screws have to be used which are often difficult to adjust with the necessary fineness, or without some bodily displacement of the whole apparatus upon the work-bench. Moreover the advantage of having the mutually perpendicular levelling motions truly independent will be appreciated. This stand will be found most convenient for supporting temporary apparatus requiring to be levelled, and it is to be especially recommended for such fine work as Lord Rayleigh's water-test for the flatness of an optical surface. The table (indicated by dotted lines in the figure) measures 30 × 30 cms.

£1. 0s. 0d. **$4.90** *c* *Infix*



No. 1007. $\frac{1}{4}$ full size.

§ 2. SPACIAL AND ANGULAR MEASUREMENT.

Standard scales. Of nickel steel, 6 mm. thick and 25 mm. wide, divided into millimetres; in mahogany case. A ring is fitted to each of these scales in order that they may hang vertically.

No. 1008. ½ full size.

The following is an extract from a certificate recently received from the National Physical Laboratory for one of these scales:—"The Scale has been compared with the Laboratory Standards, and its coefficient of expansion has been found to be 0·0000012 per 1° C. between the temperatures 5° and 33° C.

"The absolute length from line 0 to line 50 has been found to be: 50·003$_5$ cms. at 0° C.

"The scale has been immersed in water for 48 hours and shows no sign of oxidation."

1008.	50 cm. long	£2.	5s.	0d.	$11.00 *d*	*Frank*
1009.	100 cm. long	£3.	0s.	0d.	$14.60 *d*	*Glaren*

Standard metres of invar steel. These are made of an alloy of steel containing 36 % of nickel, introduced into Metrology as the result of experiments made at the Sèvres International Bureau of Weights and Measures by Dr Guilleaume. The principal advantage of this alloy is its very slight expansion with temperature, between one-fifth and one-tenth of that of platinum, it takes a fine polish, and is non-oxidisable in dry or moist air.

1010.	**Standard metre scale of invar steel,** 10 mm. thick and 20 mm. wide divided into cms. and the first decimetre into mm.	£11.	10s.	0d.	$56.00 *a*	*Frantic*
1011.	**Standard metre scale of invar steel, H form,** divided in the neutral zone (see illustration). The divisions are millimetres, the first and last mm. being subdivided into tenths.	£14.	10s.	0d.	$70.60 *a*	*Fraternize*

No. 1011.

1012.	**Vertical stand** for supporting the above scales	£3.	0s.	0d.	$14.60 *a*	*Liege*

Certificates from the National Physical Laboratory can be supplied, at cost price, with any of the above scales.

1013. Boxwood metre scales, square edges, millimetres on one side, tenths of an inch on the other.

Each	1s.	6d.	$0.36 *d*	*Infuse*
Per doz.	15s.	6d.	$3.80 *d*	*Ingest*

1014. Millimetre paper scales, 500 mm. long. To avoid the error due to shrinkage, these are *printed dry* on stout paper from a carefully divided copper plate.

	Each ...		6d.	$0.12 *d*	*Freebooter*
Ditto	Per doz. ...	4s.	6d.	$1.10 *d*	*Freedman*

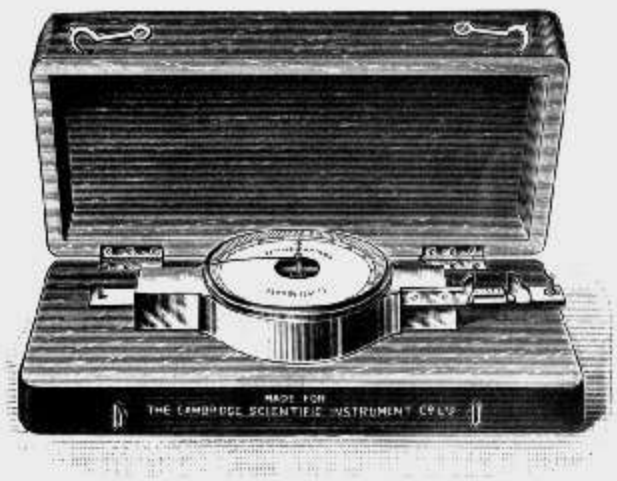
1015. Bar callipers, measuring on one side up to 12 inches by thousandths of an inch, and divided on the other side to read to ·02 millimetre. Jaws 1·75 inches long, width of jaws 0·3 inch when closed. In Morocco case complete ... **£4. 0s. 0d.** $19.50 *b* *Imprimis*

Instantaneous dial micrometers, most convenient for obtaining rapid and accurate measurements of small diameters and thicknesses. The jaws are opened by light pressure upon a thumb-lever, and close upon the piece to be measured when the pressure is withdrawn. These micrometers are used in our own shops for measuring the diameters of quartz fibres, and for testing their parallelism. They will be found especially useful for measuring the thickness of microscope cover-glasses, etc.

1016. With sapphire jaws and thumb-lever, opening to 2 mm., value of one complete turn of the index 0·4 mm. and value of each division ·001 mm., in box complete as illustrated.

£4. 2s. 6d. **$20.10** *b* *Improbity*

No. 1016.



No. 1016 a.

¼ full size.

1016 a. With steel jaws and without thumb-lever, opening to 50 mm., value of one complete turn of the counter 4 mm., value of each division ·01 mm., in box complete as illustrated.

£2. 15s. 0d. **$13.40** *b* *Imprudent*

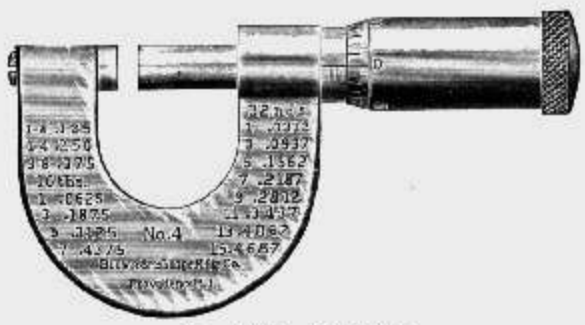
1017. Optical calliper, an instrument constructed on the optical-lever principle. The opening between the jaws is freely accessible from one side, the jaws overhanging the other parts of the instrument. The depression of a friction-tight lever allows the jaws to be closed by a very small constant force, all undue strain and shocks being avoided. Price on application.

Brown and Sharpe's micrometer callipers. The ratchet provided in certain cases is for preventing undue pressure on the faces of the gauge.

1018. Half-inch steel gauge, reading to ·001 inch, in case.

Without Ratchet
£1. 1s. 0d. *b* **$5.10** *b* *Foremost*

With Ratchet
£1. 3s. 0d. **$5.60** *b* *Fortlet*



No. 1018. Full size.

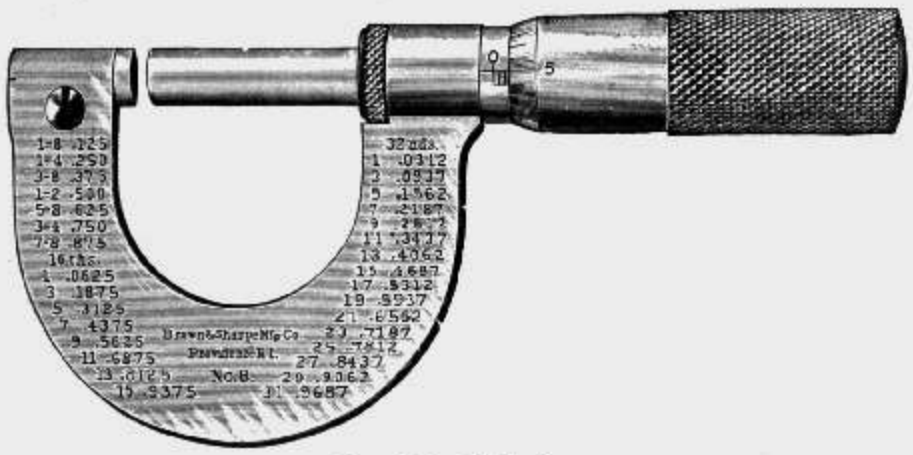
1019. 13 mm. steel gauge, reading to ·01 mm., in case.

Without Ratchet
£1. 1s. 0d. **$5.10** *b* *Fortunise*

With Ratchet
£1. 3s. 0d. **$5.60** *b* *Gingebre*

1020. One inch steel gauge, reading to ·001 inch, in case.

Without Ratchet				With Ratchet			
£1.	**5s.**	**0d.**	**$6.10** *b* *Forsando*	**£1.**	**7s.**	**0d.**	**$6.60** *b* *Fossilized*



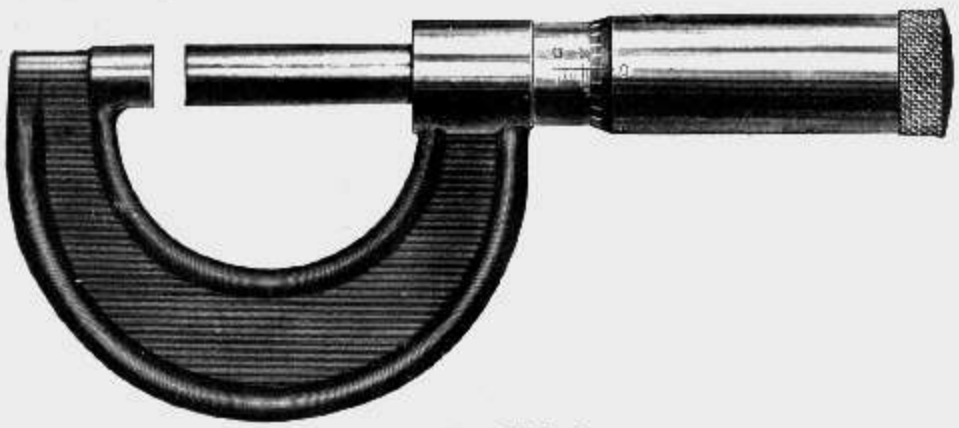
No. 1020. Full size.

1021. 25 mm. steel gauge, reading to ·01 mm., in case.

Without Ratchet				With Ratchet			
£1.	**5s.**	**0d.**	**$6.10** *b* *Canoneer*	**£1.**	**7s.**	**0d.**	**$6.60** *b* *Lipgood*

Micrometer callipers. A cheap but good form having a bow of I-section with the anvil formed solidly on the steel frame, the adjustment commonly made by an anvil screw being effected at the other end. The figure shows the 1 inch calliper, full size, which measures from 0 to 1 inch in thousandths.

1021 a.	0 to ½ inch	... ...	**15s.**	**0d.**	**$3.65** *b*	*Ionic*
1021 b.	0 to 1 inch	.. ..	**17s.**	**6d.**	**$4.25** *b*	*Iota*
1021 c.	1 to 2 inches	... .	**17s.**	**6d.**	**$4.25** *b*	*Irony*



No. 1021 a. Full size.

1022. Cup micrometer, for measuring small vertical movements, to one-hundredth of a millimetre. Useful in many cases where a cathetometer is commonly used. A cup is fixed to the upper end of the micrometer screw and is partially filled with oil. A needle is then attached to the object whose movement is to be measured. It should be vertical, with the point downward, and directly over the oil cup. The micrometer screw is turned and the reading taken when the needle point is seen to touch the surface of the oil; the image of any object reflected in the surface of the oil being distorted at the moment of contact. It is sometimes more convenient to place the oil cup on the object to be measured and to fix the needle to the lower end of the micrometer screw as shown in the figure. In case. ... **£4. 4s. 0d.** **$20.50** *c* *Befall*

Stand extra (see p. 1, No. 1002 a).

1023. Measuring machine (see illustration). The micrometer-screw is of comparatively open pitch, with a correspondingly large divided head, read by means of a vernier.

The main screw can be rotated for quick movement by a knurled nut at the end of the spindle. For slow movement, a fine adjustment screw is carried on an arm which can be clamped to the wheel, at any point, and thrusts against the bar provided on the front of the head.

Readings are given to $\frac{1}{100000}$ of an inch.

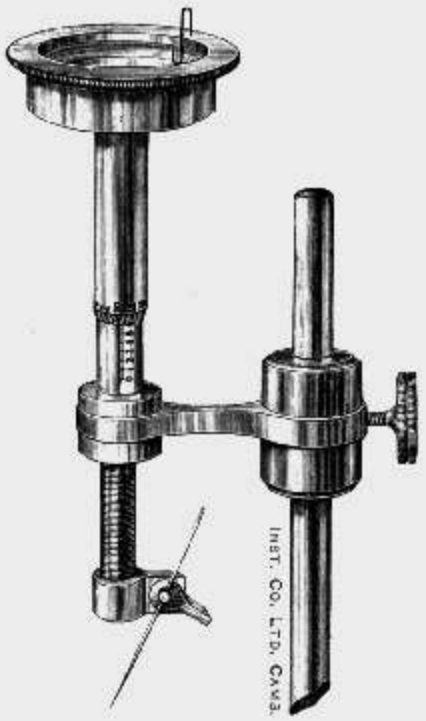
By reversing the fine adjustment arm, so as to use the back thrust bar as a positive stop, and setting the machine to a size, comparisons of any number of pieces of the same size can be obtained by observing the position of the bubble on the spirit level, which is seen on the tail-stock.

When so ordered the machines are fitted with Rules and Microscopes as figured. The rules are of invar and are graduated in inches with microscopic lines.

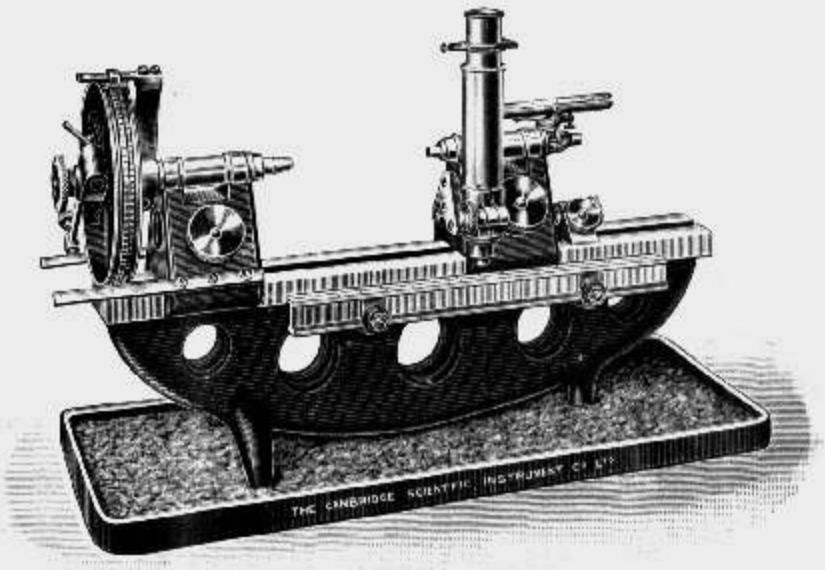
Rests for supporting end rods on the centre of the bed are supplied with the machines.

Capacity	Price	$	Code Word	Complete with Rule and Microscope	$	Code Word
12″	£35. 0s. 0d.	170.50 *b*	*Jostle*	£50. 0s. 0d.	243.50 *b*	*Jambee*
24″	£50. 0s. 0d.	243.50 *b*	*Joust*	£70. 0s. 0d.	341.00 *b*	*Jangler*
48″	£60. 0s. 0d.	292.20 *b*	*Jowler*	£85. 0s. 0d.	414.00 *b*	*Jargon*

The above prices include Polished Hardwood Case.



No. 1022. $\frac{1}{2}$ full size.



No. 1023. $\frac{1}{4}$ full size.

1024. Quincke's microscope cathetometer. The differences of level are read by a micrometer eye-piece placed in a horizontal microscope of small magnifying power. The eye-piece scale has 5 mm. divided into 50 parts, and figured. The microscope frame, which can slide about on a small glass table, is placed horizontal by means of a spirit level.

£6. 0s. 0d. $29.25 *c* *Carriboo*

1025. Micrometer telescope, as used by Principal Griffiths, F.R.S., for reading thermometers. The telescope is supported by a carriage sliding on a vertical steel rod fixed to a cast-iron tripod foot.

The telescope has an object glass of very short focal length and may be described as a very low-power microscope. A finely ruled glass scale is fixed at the focus of the eye-piece and the draw tube is to be adjusted so that 10 divisions of this scale correspond to one millimetre or one scale division of the object examined (see illustration). £5. 10s. 0d. $26.80 *c* *Forswear*

1026. Telescope and Scale. The scale is 40 cm. long, divided in millimetres and figured; it can be placed either horizontally or vertically and adjusted to horizontality or verticality by means of a foot screw; it can also be slid lengthwise in its clip.

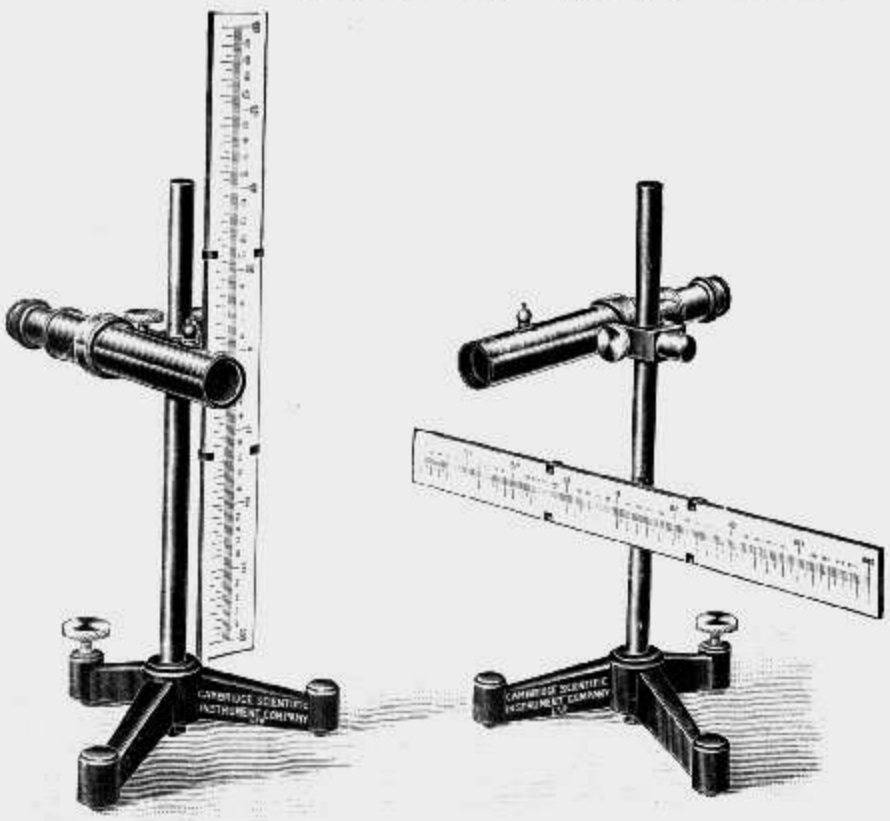
The telescope can be tilted, and clamped at any inclination.

Both telescope and scale can be swivelled round or adjusted in height upon the vertical stem.

Price complete, with iron stand ... ... **£3. 17s. 6d.** **$18.90** *d* *Haughty*

" " with brass stand ... ... **£4. 2s. 6d.** **$20.10** *d* *Hauteur*

No. 1025. ⅓ full size.

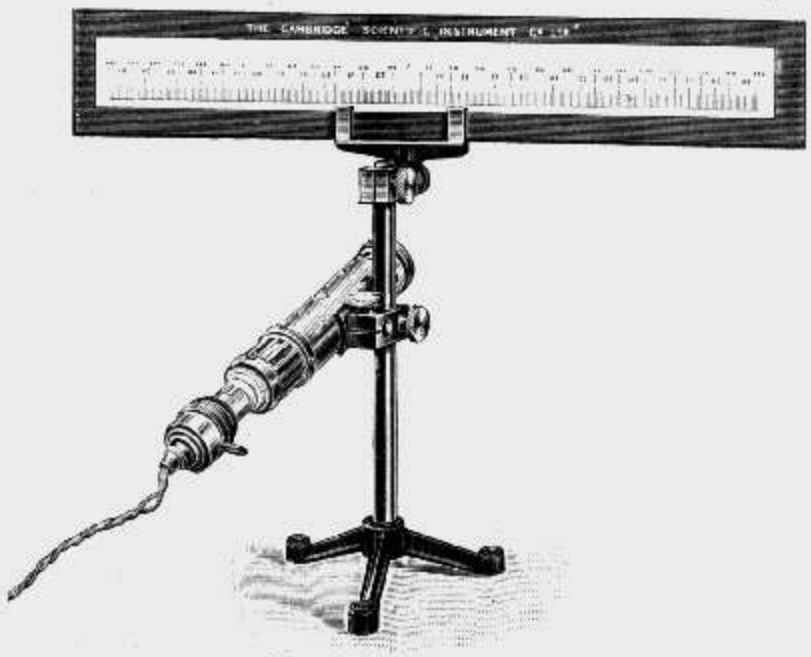


No. 1026. ⅓ full size.

1026 a. Nernst Lamp and Transparent Scale, for use with any reflecting instrument. The lamp is enclosed in a tube which is readily adjustable as to height and direction. The apparatus can be used without darkening the room, and can be readily set in any direction.

The scale can be placed horizontal or vertical; it can also be slid lengthwise in its clips, and then clamped.

To stand on table as illustrated, or to fix to a wall. **£2. 5s. 0d.** **$11.00** *d* *Headpiece*

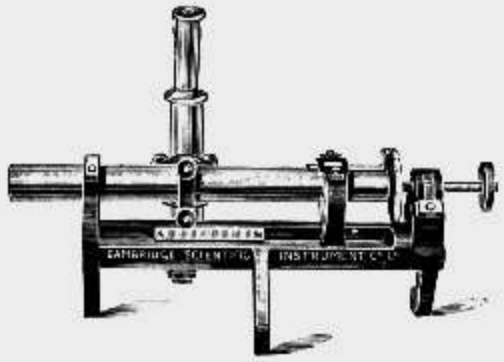


No. 1026 a. ⅓ full size.

Lamp mounted on stand, as above, but without scale. (100 volt lamps are supplied unless otherwise ordered.) ... ... **£1. 10s. 0d.** **$7.30** *d* *Lippitude*

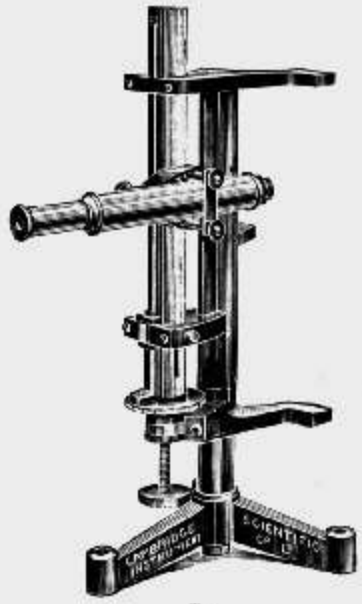
1027. Comparator. A horizontal tube has a slow traverse of 40 mm., directly read to ·01 mm. on a micrometer head. A microscope carrying cross lines can be clamped at any point of the length of the tube, and may have its axis vertical, horizontal or inclined as desired (*A*). For supporting the object under examination, a small sliding table with centring adjustments is provided. A tripod stand (with three levelling screws, not illustrated), enabling the instrument to be used as a Cathetometer is also supplied (*B*). Complete with tripod stand.

£12. 10s. 0d. $60.90 *d* *Forlaying*



A

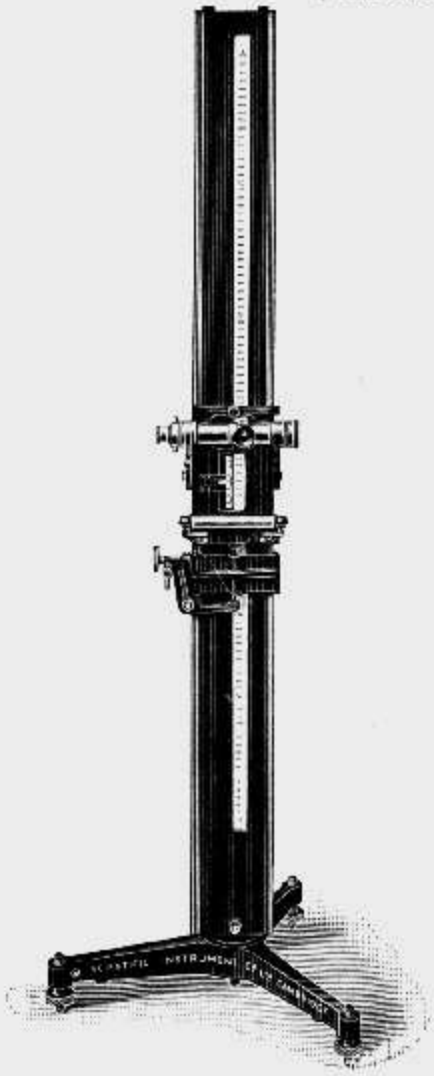
¼ full size.



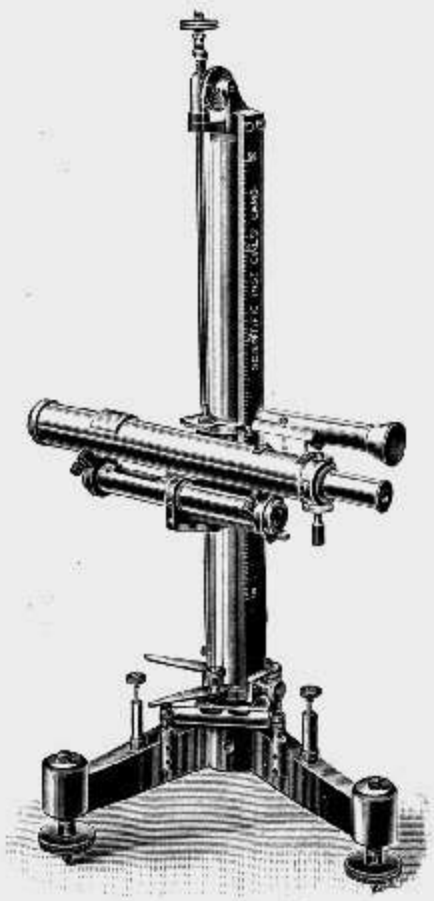
B

¼ full size.

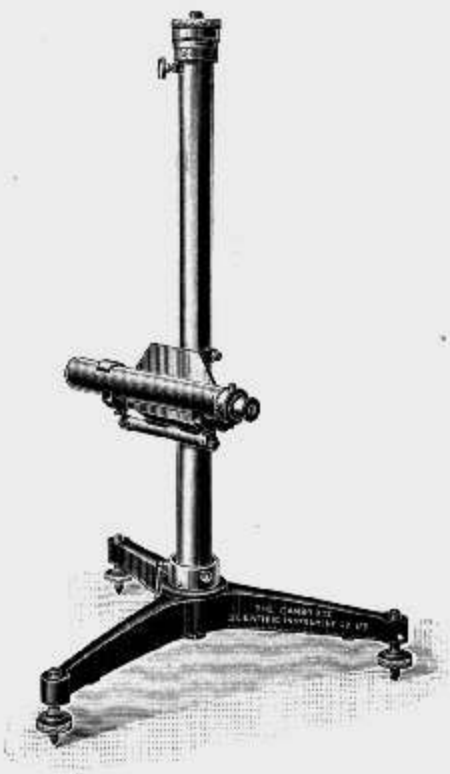
No. 1027.



No. 1029. $\frac{1}{12}$ full size.



No. 1030. $\frac{1}{7}$ full size.



No. 1031. $\frac{1}{10}$ full size.

1028. Cathetometer. The tripod foot has levelling screws, and is provided with two spirit levels. The telescope is supported by a carriage sliding with geometric contact on a vertical steel rod 75 cm. long fixed to the tripod foot. The telescope is furnished with a level, and has a vertical slow motion. Its clear aperture is 25 mm. and working distance from 1 metre to infinity.

£10. 10s. 0d. $51.20 *c* *Formalism*

1029. Cathetometer, with heavy column 1·15 metres high turning on its axis. The scale is divided into millimetres, the vernier reading to $\frac{1}{50}$ mm. The telescope has rack and pinion focussing and sensitive spirit level. The object glass is of 27 mm. aperture. Readings may be obtained at distances ranging from 60 cms. to infinity (see illustration).

£38. 0s. 0d. $185.00 *d* *Formic*

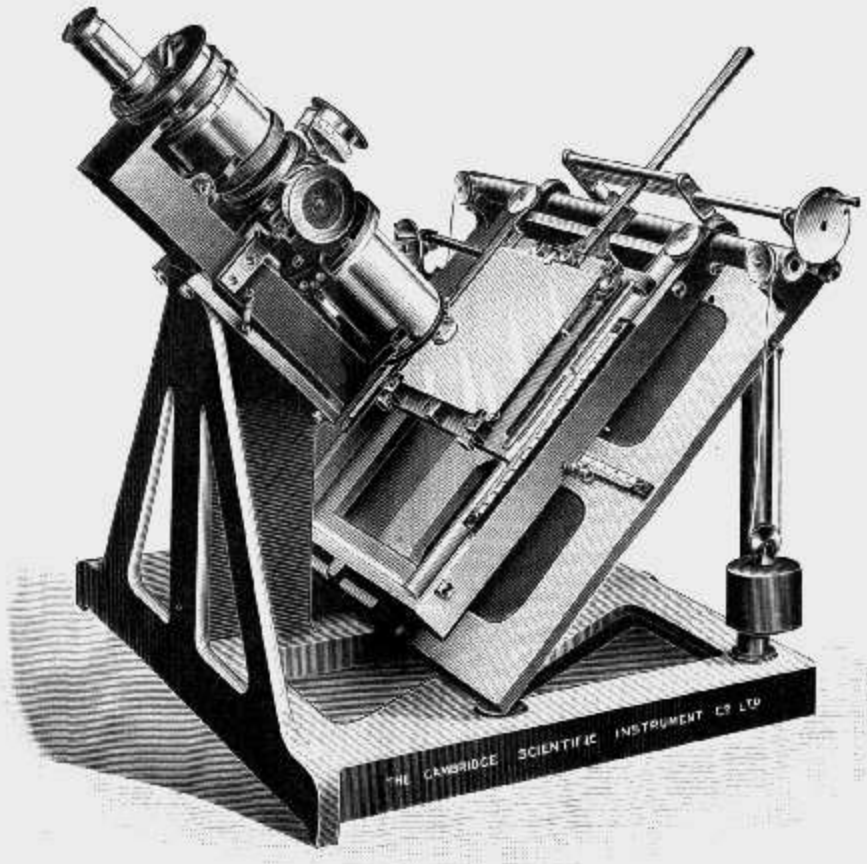
1030. Table cathetometer. The vertical support of this instrument is a weldless steel tube standing on a tripod foot, fitted with spirit levels. The telescope has an object glass of 23 mm. diameter. The scale is 50 cm. long and divided to millimetres. A novel arrangement is fitted for subdividing the scale readings to 0·02 mm. (see illustration).

£40. 0s. 0d. $194.80 *b* *Girdlebel*

1031. Cathetometer, for use in conjunction with a standard scale. The whole pillar can turn about its axis, and can be raised or lowered micrometrically through a vertical range of 25 mm.; the readings of the micrometer-head being used to subdivide the scale readings. The vertical range of the telescope upon the pillar is 50 cm. (see illustration).

£13. 15s. 0d. $67.00 *c* *Kermes*

1032. Star-photograph micrometer (see illustration). This instrument is a modified form of that which was originally designed by Mr A. R. Hinks and supplied by us to the University Observatory, Cambridge, England. Its function is to determine the exact co-ordinates of a star



No. 1032. $\frac{1}{5}$ full size.

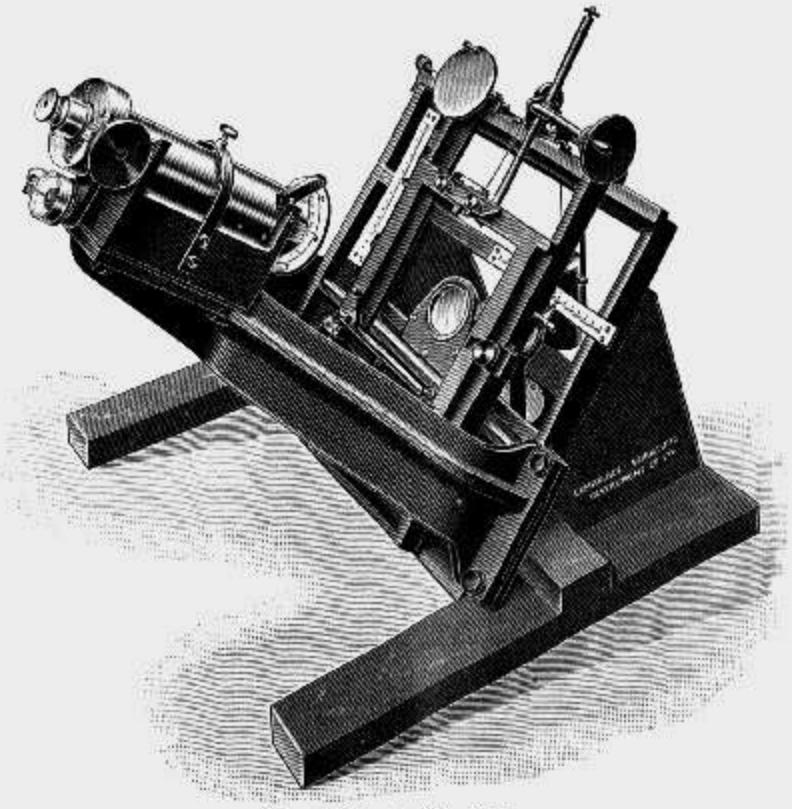
or other celestial object upon a photographic plate ($6\frac{1}{4}'' \times 6\frac{1}{4}''$) impressed with a standard réseau. The plate is mounted in a frame which enables it to be traversed in its own plane parallel to either set of réseau lines as required. A microscope is rigidly carried by a bracket attached to the same frame, and serves for viewing the photograph. The objective of the microscope is so

arranged as to produce unit magnification, a special adjustment being included to secure this result; thus in the second focal plane of the object glass, a real image of the photographic plate with the réseau upon it is projected. In this focal plane also is a finely divided scale which serves to measure to the nearest $\frac{1}{20}$ mm. the distance of any star image from the nearest adjoining réseau line. Finally fractional parts of $\frac{1}{20}$ mm. are determined by traversing this scale in the focal plane by means of a fine screw with micrometer head. The réseau lines are generally 5 mm. apart, so that the co-ordinates of a star image are read to the nearest 5 mm. by means of the réseau, to the nearest $\frac{1}{20}$ mm. by means of the scale in the secondary focal plane, and fractions of $\frac{1}{20}$ mm. by means of a micrometer screw. This arrangement is found to be susceptible of a very high degree of accuracy, any errors of pitch in the micrometer screw affecting only a small term (less than $\frac{1}{20}$ mm.) in the observed co-ordinate. The errors of this instrument have been found to be inappreciable. (See "The Cambridge Machine for Measuring Celestial Photographs," by A. R. Hinks, *Monthly Notices, Roy. Astron. Soc.*, Vol. LXI. p. 444.) **£125. 0s. 0d.** **$608.75** *b* *Kirkman*

1033. Star-photograph micrometer (see illustration) for plates $6\frac{1}{4}$ in. × $6\frac{1}{4}$ in., of less elaborate construction than the above, but capable of doing highly accurate work.

£50. 0s. 0d. **$243.50** *b* *Kilding*

1033 a. Ditto, ditto. for plates 12 in. × 10 in. **£70. 0s. 0d.** **$341.00** *b* *Impunity*



No. 1033. $\frac{1}{4}$ full size.

1034. Co-ordinate comparator. For determining the co-ordinates of any selected points upon a quarter-plate photograph or the like, with an accuracy of 0·01 mm. (see illustration).

£12. 10s. 0d. **$60.90** *b* *Kneepan*

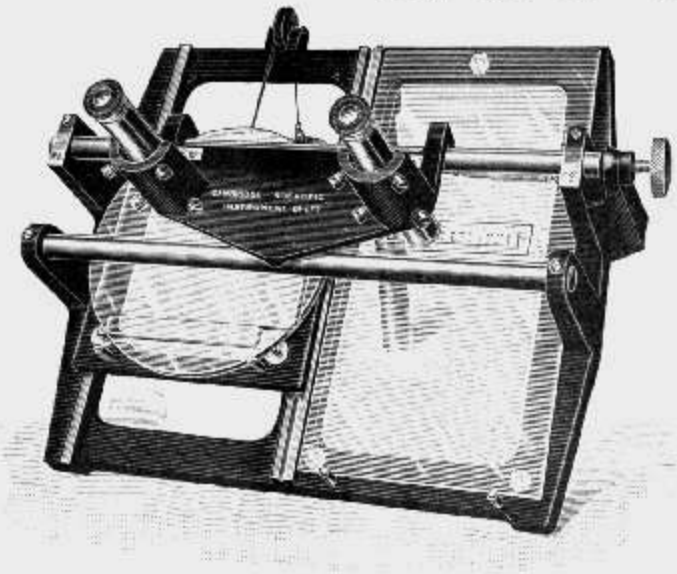
1035. Screw Measuring Machine, for determining accurately the errors of screws up to $\frac{1}{2}$ inch (12·5 mm.) diameter, as supplied to the National Physical Laboratory, to the Japanese Government, to Messrs Ludwig Loewe & Co., &c. The elements which can be measured are:

External diameter;
Diameter at root of thread;
Pitch;
"Effective diameter" (of V-threads);
Inclination of side of V;

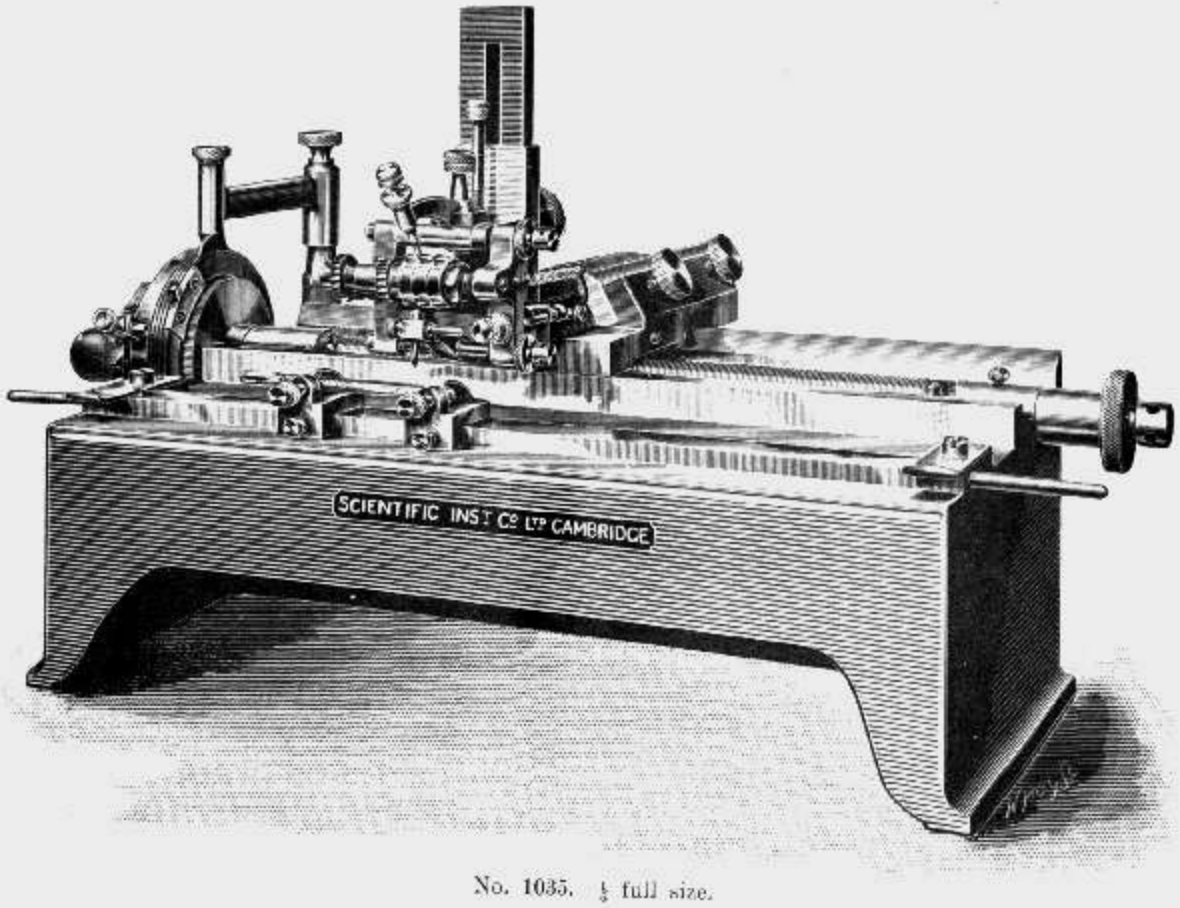
as well as the variations of these quantities from one part of the thread to another (see *Engineering*, November 13th, 1903). ... ... **£52. 10s. 0d.** **$255.70** *c* *Impurple*

1036. Dividing machine for making straight scales of any length less than 35 cms. The screw is of 1 mm. pitch and traverses a sliding carriage carrying the engraving point. The gun-metal nut is hinged and split so as to be readily disengaged from the screw to allow of quick traverse. The bed and fittings are of a specially rigid character. Special clamps for fixing thermometer and barometer tubes and flat scales are supplied. The micrometer head is divided into 200 parts. Lengths can thus be measured to ·004 mm. (see illustration).

£59. 15s. 0d. $291.00 *a* *Fresknew*



No. 1034. ⅓ full size.



No. 1035. ⅛ full size.

1036 a. Ditto, ditto, with microscope attached to the carriage.

£62. 15s. 0d. $305.60 *a* *Keystone*

This machine is strongly recommended for general laboratory work.

1037. Ditto, ditto. To divide a maximum length of 50 cm., including microscope.

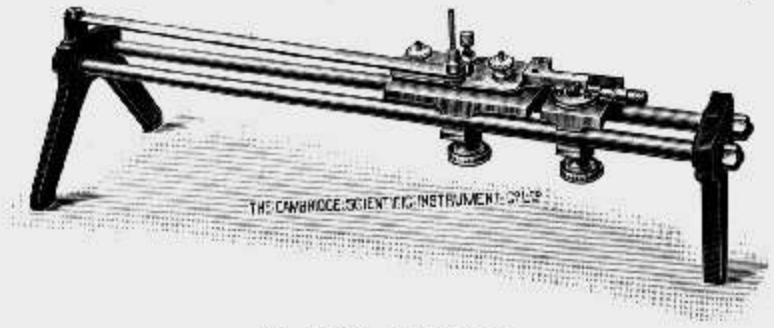
£67. 15s. 0d. $315.40 *a* *Lieu*

1038. Ditto, ditto. To divide a maximum length of 100 cm., including microscope.

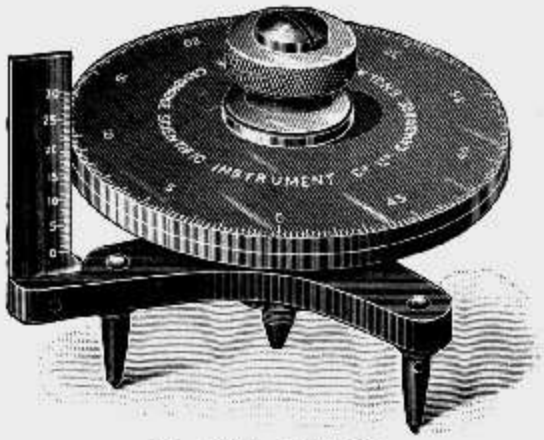
£79. 15s. 0d. **$373.80** *a* *Life*

1039. Step by step dividing machine, useful for dividing verniers and short scales. The graving tool is carried at the end of a long arm, and the scale to be divided is mounted on a carriage whose advance at each step is determined by means of a micrometer screw (see illustration).

£6. 10s. 6d. **$31.80** *c* *Descrying*



No. 1039. ¼ full size.



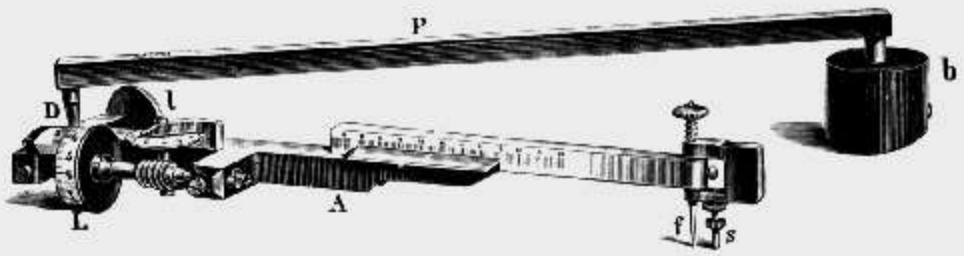
No. 1040. Full size.

1040. Spherometer (see illustration). For each division of the micrometer head the point of the screw advances by 0·002 mm. The legs are removable, and can be screwed into either of two sets of holes. In the inner position the feet lie on a circle of 1·5 cm. radius, in the outer position, 3 cm. radius. In reading the whole turns and parts of a turn, engraved lines (not edges) serve as the respective reading marks. In mahogany case.

£4. 4s. 0d. **$20.50** *c* *Knobby*

1041. Amsler's planimeter, "compensation" type (see illustration). The pole arm can be placed on either side of the tracer arm, so that by taking the mean of the measurements made in these two cases, any small error due to imperfect alignment of the axis of the roller may be eliminated. Adjusted for 1 vernier unit *only*, between 8 and 10 square mm. (0·016 square inch to 0·0125 square inch) as desired, length of pole arm 19 cm. (7½″), length of tracer arm 16 cm. (6½″); the adjustable piece carrying the tracer is made of German silver and screwed on the tracer arm from underneath, it has a graduation in ½ mm., on which an index mark indicates the length of the tracer arm. Roller of nickel steel, graduation of the roller and counting wheel on celluloid; convenient winged handle and support with testing rule and case.

£2. 13s. 6d. **$13.00** *c* *Inaidable*



No. 1041. ⅓ full size.

1042. Amsler's planimeter, "compensation" type, with graduated tracer arm provided with vernier and micrometer adjustment, adjustable for values of the vernier unit between 10 and 2 square mm., adjusted for 4 to 6 vernier units or settings of the tracer arm. Measuring roller and counting wheel as for No. 1041, table in the case, showing the values of the vernier unit, settings of tracer arm and constants, pole arm 19 cm. (7½″) long, winged handle and support, with neat case and testing rule, and with a convenient adjustment for placing the axis of the roller and tracer arm parallel (see illustration). ... **£3. 14s. 0d.** **$18.00** *c* *Inamorato*

1042 a. Adjusted for both metric and English units.
£4. 0s. 0d. $19.50 *c* *Inanition*

No. 1042. ½ full size.

1043. Spirit-level tester. For measuring the value of the graduations on a spirit-level tube. The tube is placed on a stand which can be tilted by means of an accurate screw, the latter being provided with a micrometer head divided on celluloid, each division of which corresponds to a tilt of one second (see illustration—the design of the instrument has been greatly improved since the illustration was made). ... ... **£3. 17s. 6d.** $18.90 *c* *Foxish*

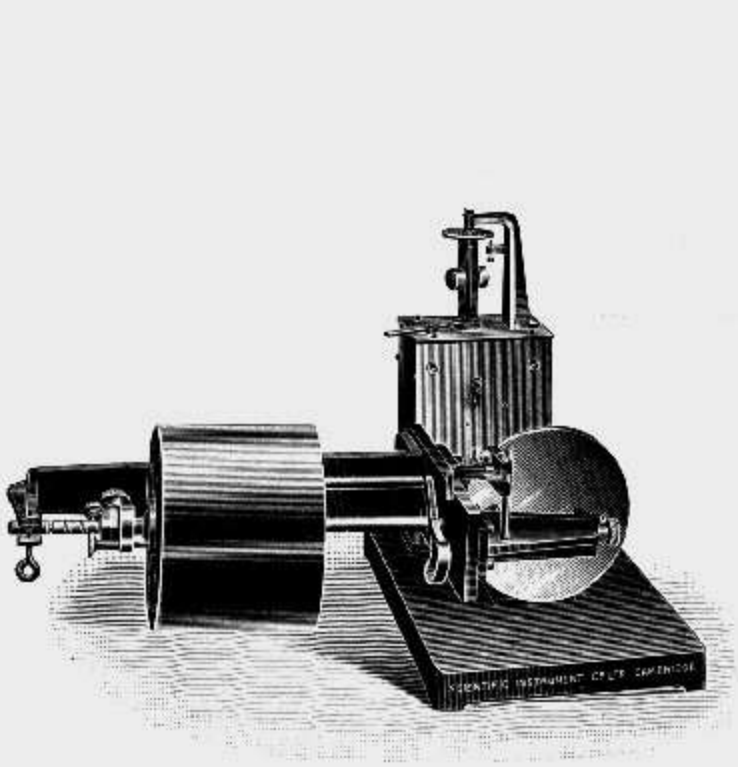
No. 1043. ½ full size.

§ 3. RECORDING AND TIME-MARKING APPARATUS.

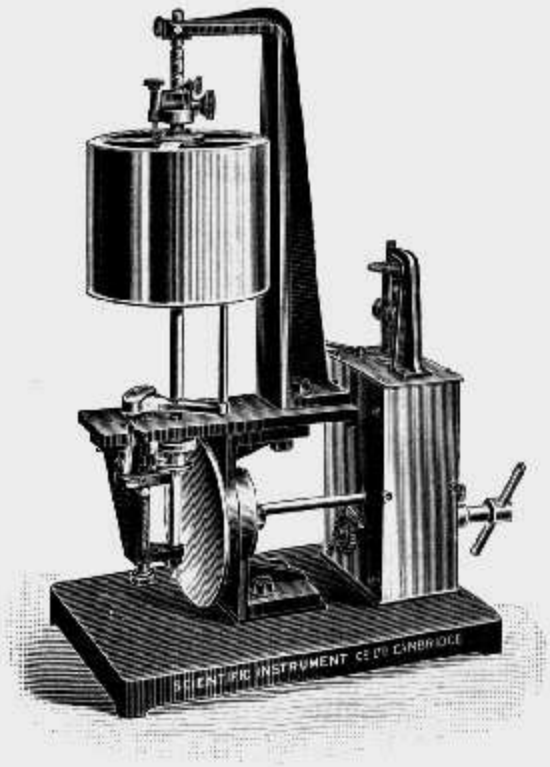
1044. Kymograph. Ludwig's model, driven by clockwork. This instrument has been entirely re-designed and is fitted with a very efficient form of governor. The clockwork is arranged to feed the revolving drum along its axis, or if desired the drum can be caused to revolve without axial motion. The drum may be placed at any angle. The illustrations show the drum as used vertically and horizontally. The surface speed of the cylinder can be varied by means of friction wheels and variable gears from 85 mm. per second to about 20 mm. in one minute. The drum is 130 mm. high and 160 mm. in diameter.

Including stand for smoking the paper on cylinder

£30. 0s. 0d. **$146.10** *c* *Abacus*



½ full size.



No. 1044. ¼ full size.

1045. Kymograph for use with a motor or quick running cord (see illustration). The drum is 130 mm. high and 160 mm. in diameter, and can easily be removed when it is required to attach and smoke the paper. The mechanism is so arranged as to give ten different speeds. The drum will rotate in either direction, and can be made to feed slowly along its axis, thus giving a helical tracing

£13. 0s. 0d. **$63.30** *c* *Abductor*

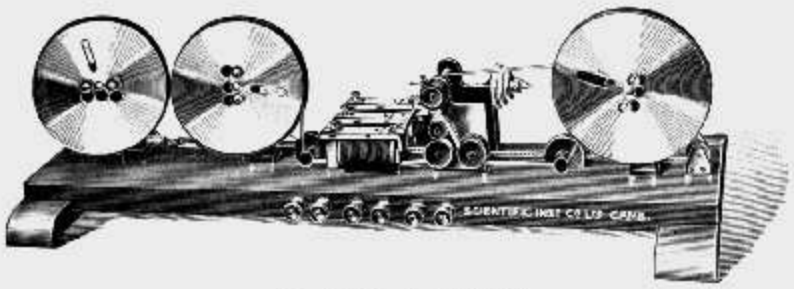
This Kymograph can be supplied with an arrangement for carrying a long sheet of smoked paper at an additional cost of £3. 10*s*. 0*d*., or for continuous paper at an extra cost of £2. 10*s*. 0*d*.

No. 1045. ⅛ full size.

1046. Simple drum. The cylinder is 130 mm. high and 160 mm. in diameter, and is fitted with a pulley for driving by a motor ... ... **£3. 0s. 0d.** **$14.60** *c* *Aboard*

1047. Chronograph for laboratory use. A strip of Morse paper 12·5 mm. wide is drawn by means of a motor under three pens attached to the armatures of two electromagnets. One of these electromagnets can be connected to a clock making contact every second; the other being used for recording the events under observation. The movement of the paper can be started or stopped whilst the motor is running ... ... **£15. 0s. 0d.** **$73.00** *c* *Carpenter*

[The illustration shows the earlier form of the instrument, the markers and inking roller have now been replaced by pens.]



No. 1047. ⅓ full size.

1048. Spare reels of Morse paper, each ... ... **1s. 0d.** **$0.24** *d* *Carpetbag*

1049. Chronograph stop-watch, as illustrated. The chronograph movement is started by pressing upon the crown, and stopped by pressing a second time, while a third pressure returns the pointer to zero, ready for another observation.

£1. 2s. 6d. **$5.50** *d* *Inanity.*

No. 1049. Full size.

1050. Chronograph, Hough's printing. As designed by Professor G. W. Hough, of the Dearborn University, Evanston, Chicago, and in use at the Durham Observatory, England. The time of any given occurrence is automatically printed by means of type wheels. An observation may be made and printed to within $\frac{1}{100}$th of a second.

To order.

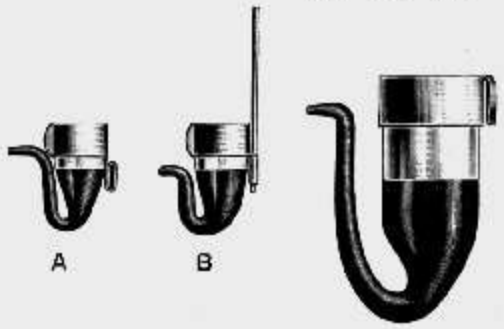
1051. Glazed paper accurately cut to size and one end gummed ready for use with our Kymograph cylinder 130 mm. high and 160 mm. in diameter:—

		£			Shouler and better quality	£		
100 sheets	5s. 0d.	1.20	*Abroad*		6s. 0d.	1.50 *d*	*Absolver*	
500 „	17s. 6d.	4.25	*Absciss*		£1. 1s. 0d.	5.10 *d*	*Abstrude*	
1000 „	£1. 12s. 6d.	7.90	*Abscond*		£2. 0s. 0d.	9.70 *d*	*Abstruisty*	

1052. Unglazed paper for continuous paper Kymographs 127 mm. wide, in rolls about 250 metres long ... ... per roll **5s. 6d.** **$1.35** *d* *Accompany*

1053. **Unglazed paper** 127 mm. wide, in rolls about 10 metres long.
per roll **0s. 10d.** $0.20 *d* *Accomplish*

1054. **Glazed paper** 127 mm. wide, in rolls about 10 metres long.
per roll **1s. 0d.** $0.24 *d* *Accordable*



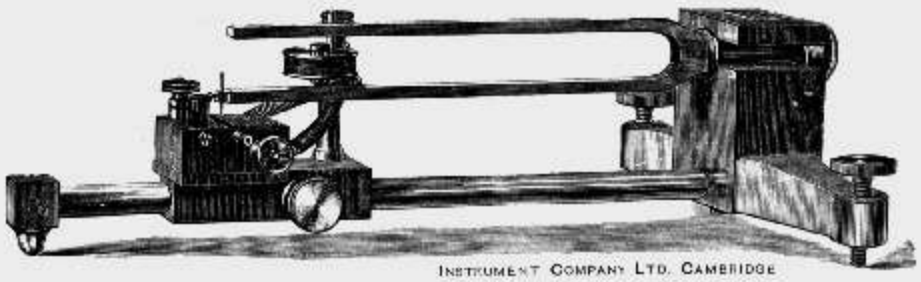
No. 1055. Full size. No. 1056. Full size.

1055. **Glass recording pen.** (See illustration.) This is a small glass vessel ending in a fine bent tube, the capillarity of which is sufficient to maintain a minute drop of ink at the writing point of the tube. There is no difficulty in keeping ink at the point however quickly the pen may be moving. At the same time the pen requires no attention when once started; it is cleaned by immersion in alcohol. The clips by which the pen is attached to the style of the instrument are made in two forms, one (A) for use when the pen is attached to the writing arm from the side, and one (B) when fixed from the top or bottom as in many recording gas and water meters. When ordering please state which form of clip is required.
1s. 0d. $0.24 *d* *Delving*

1056. **Glass recording pen,** large size, of sufficient capacity for a one month's record.
2s. 0d. $0.50 *d* *Inbeing*

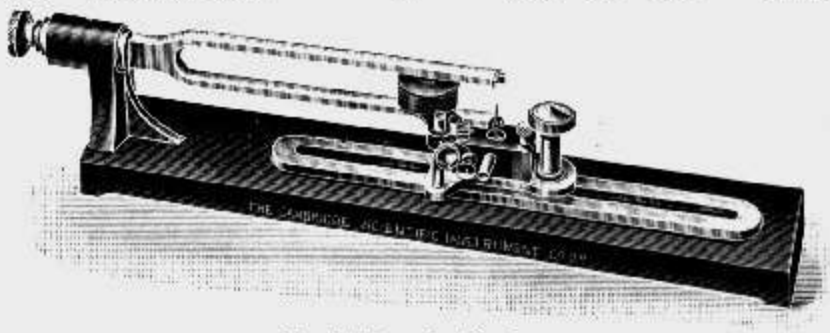
1057. Bottle of aniline ink for use with the above pens. **6d.** $0.12 *d* *Chafewax*

1058. **Tuning-fork stand,** as illustrated, for holding any of our electrically maintained tuning-forks. With electromagnet and mercury-cup contact breaker, which can be kept clean by a stream of water flowing over the mercury; provided with levelling and all other requisite adjustments. Without fork. ... ... **£4. 4s. 0d.** $20.50 *d* *Admixtion*



No. 1058. ¼ full size.

1058 a. **Tuning-fork stand,** as illustrated, for holding any of our electrically maintained tuning-forks. Complete with electromagnet and mercury-cup contact breaker, which are fully and conveniently adjustable. Without fork. ... **£3. 0s. 0d.** $14.60 *d* *Admonitory*



No. 1058 *a*. ⅓ full size.

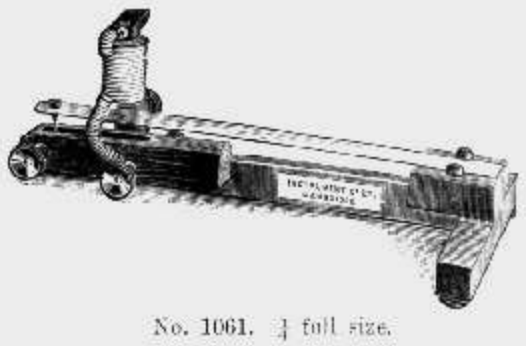
1059. Induction Coil for the above. In place of the usual simple circuit a small induction coil may be used. The primary circuit is made and broken by the vibration of the fork, while the electromagnet windings are included in the secondary circuit. Thus the forces communicated to the fork approximate closely to ideal theoretical requirements; the disturbance of the natural period is excessively small, and so small a driving current is required that sparking is reduced to a minimum. **15s. 0d.** **$3.70** *d* *Kidnap*

1060. Tuning-forks, to fit the above stands. These forks are most carefully adjusted and can be relied on for accurate work.

Fork making 50 vibrations per second. ...	**£3.**	**0s.**	**0d.**	**$14.60** *d*	*Adopt*
Fork making 100 vibrations per second. ...	**£3.**	**0s.**	**0d.**	**$14.60** *d*	*Adorn*
Fork making 200 vibrations per second. ...	**£3.**	**0s.**	**0d.**	**$14.60** *d*	*Adrift*

Any of the above forks can be fitted with slits for observing periodic phenomena as in Dr Drysdale's method for the determination of the slip of induction motors (*see Electrician*, Aug. 25, 1905). ... ... Extra **£1. 0s. 0d.** **$4.90** *d* *Inborn*

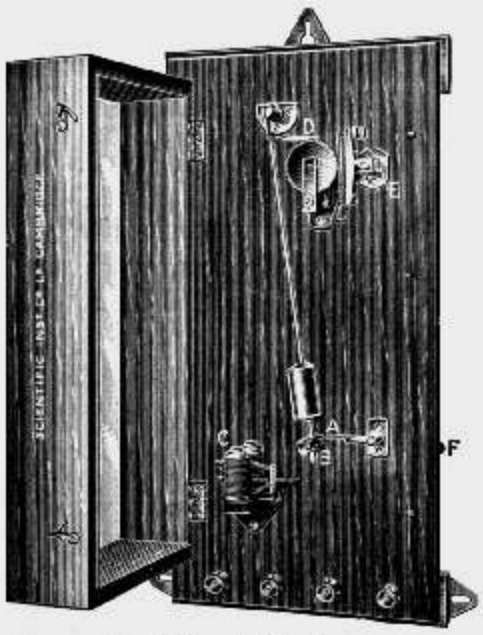
1061. Contact breaker to interrupt the current ten times per second. A horizontal steel spring fixed to a cast-iron stand oscillates and completes contact by means of a wire dipping into a mercury cup. The intermittent current thus produced passes through an electromagnet placed above the spring and keeps it vibrating (see illustration). **17s. 6d.** **$4.25** *c* *Advolition*



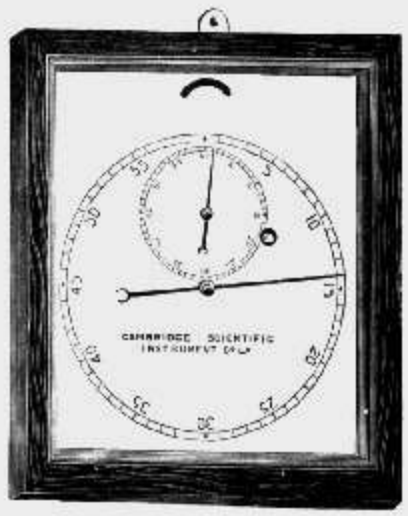
No. 1061. ¼ full size.

1062. Clock, for making an electric contact at each second, by means of a platinum wire dipping into a mercury cup. ... ... **£2. 0s. 0d.** **$9.75** *c* *Advows*

1063. Brodie's time-marking clock. This clock makes a quick and definite electric contact every second, or every two, ten, thirty, or sixty seconds as desired. The motion of the pendulum is maintained electromagnetically and can be readily started or stopped. In polished mahogany case with glass front (see illustration). ... ... **£5. 0s. 0d.** **$24.40** *d* *Cashiering*



No. 1063. ¼ full size.



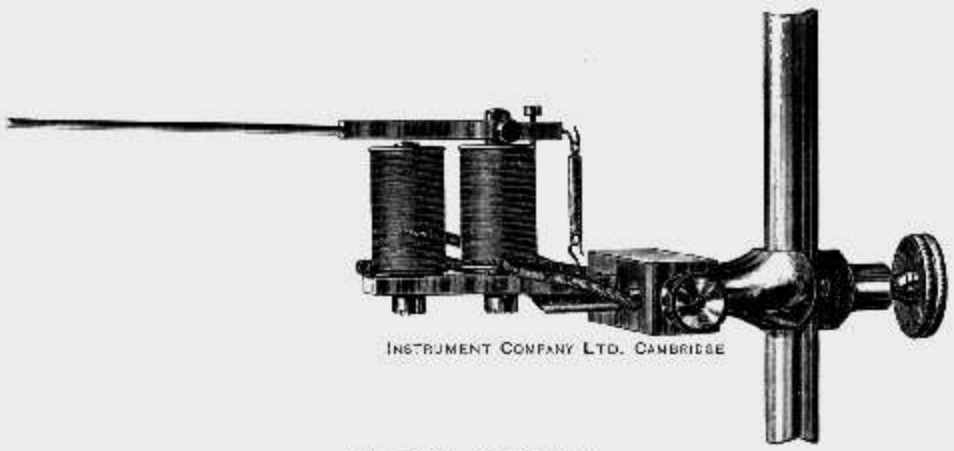
No. 1064. ⅛ full size.

1064. Laboratory seconds clock, to stand on the table or hang on the wall of a laboratory. The seconds dial is 150 mm. in diameter (see illustration).

£1. 10s. 0d. **$7.30** *c* *Chainbolt*

1065. Time-marker for smoked paper (see illustration), with fine adjustment (not shown) for approximating to the recording surface. This can be used with the currents from an Electrically Maintained Tuning-Fork of slow vibration. In box complete.

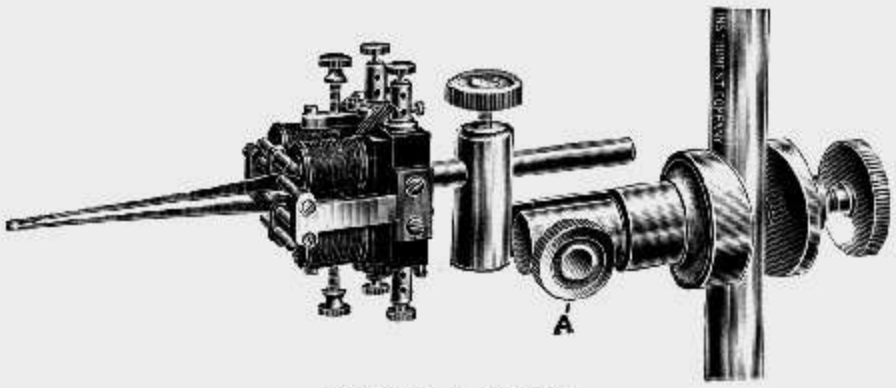
£1. 15s. 0d. **$8.50** *c* *Affluxion*



No. 1065. ⅓ full size.

1066. Double time-marker for smoked paper, with fine adjustments for approximating to the recording surface, in box complete. ... **£2. 10s. 0d.** **$12.20** *c* *Imputable*

1067. Time-marker, Deprez signal, with fine adjustment for approximating to the recording surface. In this form the electromagnets are small and the moving parts extremely light. It is useful for recording small intervals of time on smoked paper and for use with time-marking tuning-forks. In box complete. ... ... **£2. 10s. 0d.** **$12.20** *c* *Aforehand*



No. 1068. ¾ full size.

1068. Double time-marker, Deprez signal, with fine adjustment for approximating to the recording surface. There are two small electromagnets whose styles have their writing points close together. In box complete. ... ... **£3. 15s. 0d.** **$18.30** *c* *Dalster*

For prices of stands for supporting the time-markers, see p. 1, No. 1002 a.

§ 4. MECHANICS.

Instruments with the letter "E" placed after the number are of the form originally designed by Dr Ewing, F.R.S., for use in Mechanical Engineering Laboratories.

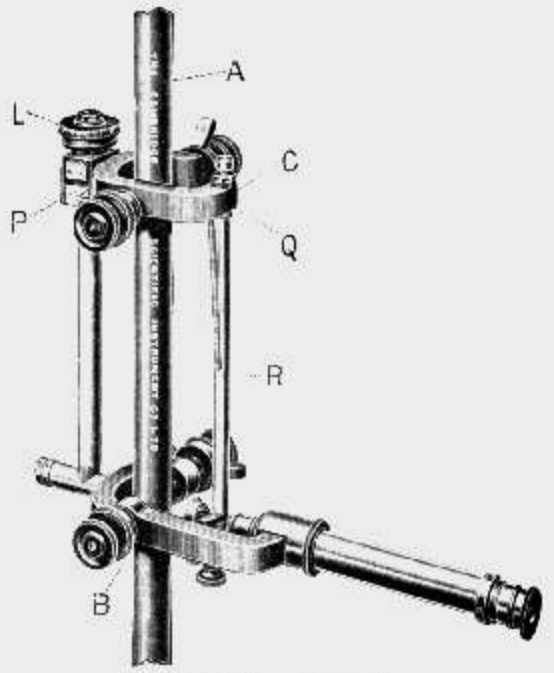
1100 E. Extensometer (Ewing's Microscope Type), (see illustration), for measuring the elastic extension and Modulus of Elasticity of specimens of metal under tensile tests. This instrument can be quickly applied to any test-piece, and no part of it has to be touched whilst the test is being made.

The illustration shows the usual form of the complete instrument. The clips *B* and *C* are set at 8 inches apart; instruments to take specimens of other lengths are constructed to order.

The displacement is read by means of a micrometer scale in the eye-piece of the microscope, each division corresponding to $\frac{1}{5000}$ inch of extension so that by estimation of tenths of a division readings to $\frac{1}{50000}$ inch may be taken.

A screw *L* further serves to bring the sighted mark to a convenient point on the micrometer scale and also to bring the mark back if the strain is so large as to carry it out of the field of view.

The instrument is applicable to large or small test-pieces, and can be used on testing machines of either the vertical or the horizontal type. (See Ewing's *Strength of Materials*, p. 78, University Press, Cambridge.)

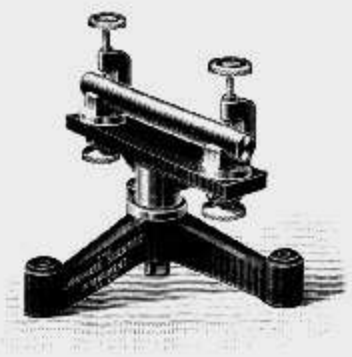


No. 1100 E. ⅓ full size.

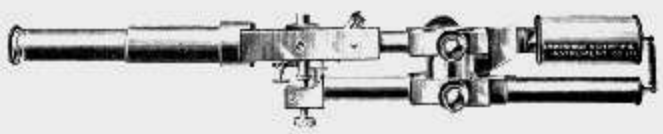
In polished mahogany case, complete. ... **£27. 10s. 0d.** **$134.00** *c* *Demarcate*

1101 E. Apparatus for Marking off Standard Length on Test-Pieces for measurements of elastic extension, for use with Extensometer, as illustrated.

£4. 0s. 0d. **$19.50** *c* *Demon*



No. 1101 E. ⅓ full size.



No. 1102 E. ⅓ full size.

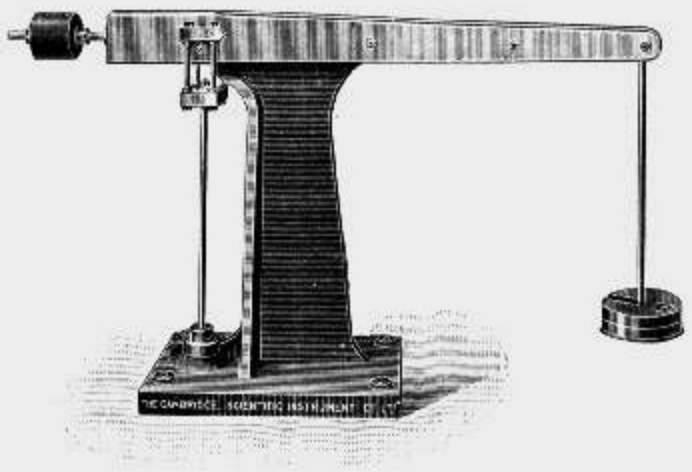
1102 E. Ewing's Compression Extensometer (see illustration). Special form for measuring the elastic compression of short blocks. See Ewing's *Strength of Materials*, p. 79.

£25. 0s. 0d. **$121.75** *c* *Demonship*

1102 a. Apparatus for Marking off Standard Length on Test-Pieces for the compression extensometer. ... ... **£5. 0s. 0d.** **$24.00** *c* *Liripoop*

1102 b. Flexion Indicator, as supplied to Messrs Dorman, Long & Co., Middlesbrough, England, for measuring the deflection produced in steel beams by the application of a known load. According to requirements from ... ... **£16. 0s. 0d.** **$76.80** *c* *Listener*

1103 E. Single Lever Testing Machine for use with Extensometer in measuring modulus of elasticity in rods up to $\frac{3}{8}$ in. (10 mm.) diameter, with assortment of rods of various metals. Length of rods 50 cms. The maximum total load provided for is 1·2 tons. Ten weights equivalent to $\frac{1}{10}$ ton and four equivalent to $\frac{1}{20}$ ton are supplied. See Ewing's *Strength of Materials*, p. 80. (See illustration.) ... ... **£18. 10s. 0d.** **$90.10** *c* *Inchoate*



1103 E. $\frac{1}{5}$ full size.

1104. Young's Modulus of Wires, Searle's Apparatus for Determining, and also the deviations from Hooke's Law (see illustration).

The upper ends of two wires are securely fixed to a beam, and from the lower ends hang two brass frames supporting the two ends of a sensitive level. One end of the level is pivoted to one of the frames; the other end of the level rests upon the end of a micrometer screw; divided and figured on celluloid.

Extensions in the length of the wire under observation can thus be read directly to ·01 mm.

£3. 15s. 0d. **$18.25** *c* *Caloptric*

1104. $\frac{1}{2}$ full size.

1105. $\frac{1}{3}$ full size.

1105. Young's Modulus of Wires, Apparatus for Determining (see illustration). This instrument is similar to that shown in Glazebrook & Shaw's *Practical Physics*, and consists of a scale, vernier reading to fiftieths of a mm. on the scale, scale-pan, weight, and bracket to fix to a wall for holding the wires at the top. Wires varying greatly in size can be easily and firmly clamped. ... ... **£1. 7s. 6d.** **$6.70** *c* *Caulked*

1106. Comparison of Rigidity with Young's Modulus of Wires, Searle's Apparatus for (see *Phil. Mag.* Feb. 1900). Two brass bars of square section weighing about 400 grammes each, are suspended by means of hooks, and are connected by a known length of the wire whose modulus is required. Three wires of different metals are supplied with the apparatus.
£1. 0s. 0d. **$4.90** *c* *Causator*

1107. Variable Inertia Bar and Bifilar Suspension. A horizontal tubular bar is suspended from a laboratory stand (see No. 1002 b) by means of a wire or of a bifilar suspension. The moment of inertia of the suspended system is increased by two equal masses of metal which are transfixed by it, and can be adjusted lengthwise of the bar by hand. Means are provided for reading accurately against a scale the positions of the metal masses. Thus a known change is made in the total moment of inertia of the system by equally displacing the equal masses inward or outward through a measured distance. The metal masses can both be reversed upon the bar, the apparatus being capable of giving, in the hands of a careful student, a very accurate value of the torsional coefficient of the suspending wire or bifilar. Means for varying the bifilar suspension are provided, so that the laws of the bifilar can be verified. A full explanation is sent out with each instrument.

With suspension bracket ready for fixing to laboratory stand.
£4. 15s. 0d. **$23.15** *d* *Inditer*

Complete with stand ... ... **£5. 1s. 6d.** **$24.70** *d* *Indocile*

1108 E. Maxwell's Vibrating Needle for finding the Modulus of Torsion of a Wire. Into a horizontal brass tube four other equal tubes can slide, and thus fill up its whole length. Two of these tubes are empty and two are full of lead. By placing the full or empty tubes nearest the centre the moment of inertia is changed, and observations of the corresponding periods of swing give the data required. Clamps for working with different wires are supplied. Complete with stand as illustrated.
£4. 5s. 0d. **$20.70** *c* *Depone*

No. 1108 E. $\frac{1}{10}$ full size.

1109. Torsional Rigidity of Wires, static apparatus for determining. The upper end of the wire is held in a torsion head, reading on a divided circle. The lower end of the wire carries a light horizontal rod, each end of which is attached to one of a system of three concurrent wires, which enable known turning-moments to be applied to the bar. When displaced by changing the turning moment, the bar is restored to its original position by turning the torsion head, the angle of torsion corresponding to a given moment being thus directly read.

Complete on base ... **£5. 0s. 0d.** **$24.35** *d* *Indue*

1110 E. Torsion of Wires, Static Observation of (see illustration), also serving for vibration experiment in measuring the modulus of torsion. A true couple is applied to the lower end of the wire examined, the forces composing the couple being transmitted by pulleys mounted on ball bearings, and the angle of torsion read off by means of a pointer on a scale divided in degrees. See Ewing's *Strength of Materials*, p. 86.

£11. 10s. 0d. $56.00 *c* *Deposed*

1111. Torsion of Rods, apparatus for observing. Very similar to Professor Perry's form. The rod is clamped at the upper end, while its lower end supports horizontally a large grooved pulley. To this pulley a couple is applied by means of two cords which pass over guide pulleys and support equal weights. Pointers can be attached at three points of the rod, their positions corresponding to different torsional moments being read off on divided dials.

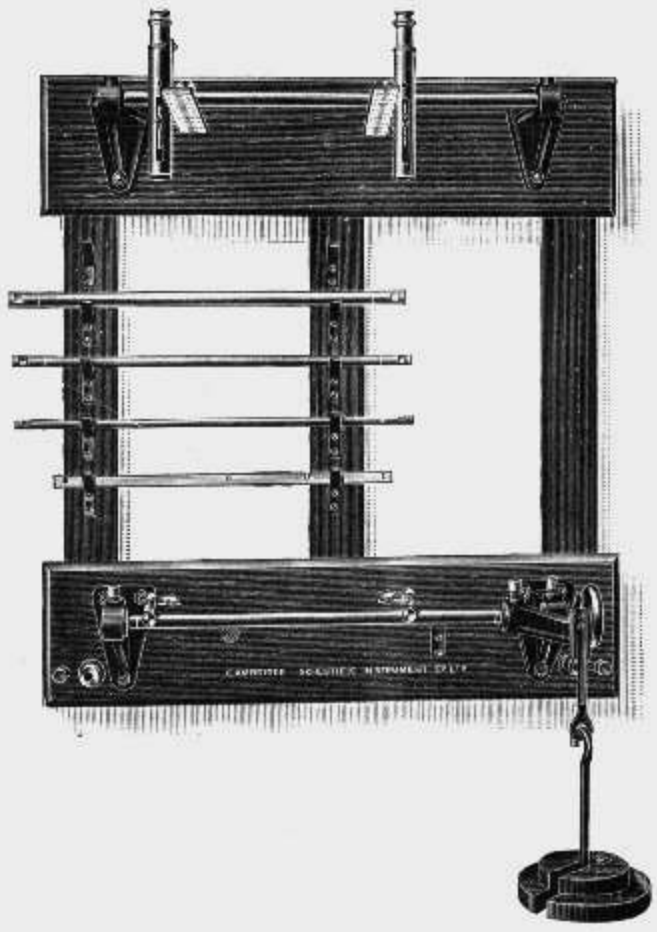
With weight carriers, but without weights.

£8. 0s. 0d. $39.00 *c* *Inedited*

No. 1110 E. $\frac{1}{7}$ full size.

1112 E. Apparatus for Measuring Modulus of Torsion in Rods up to 25 mm. in diameter, and 64 cm. long, with two reading telescopes and mirrors, for attachment to a wall, complete with assortment of rods. A scale-reading of 1 mm. corresponds to a torsional angle of ·00071 radian. The following weights are supplied: three 5 lb., two 2 lb. and one 1 lb. See Ewing's *Strength of Materials*, p. 86. As illustrated.

£20. 0s. 0d. $97.40 *c* *Depeopled*



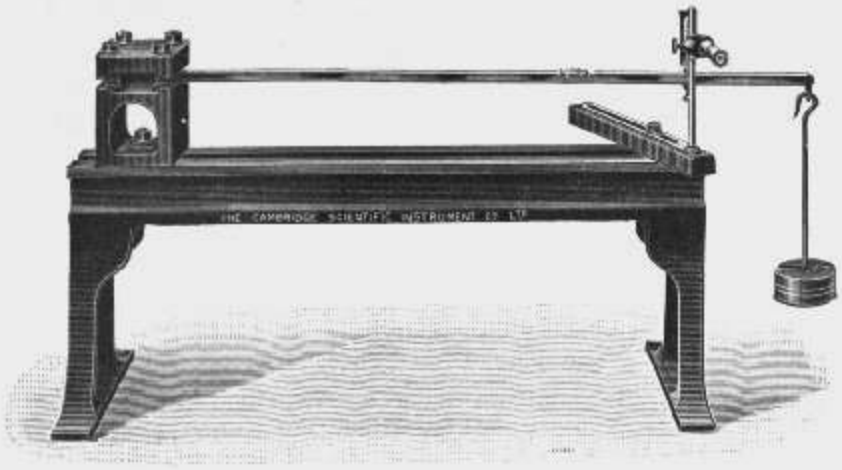
No. 1112 E. $\frac{1}{13}$ full size.

1113. Knife-edge Brackets, of cast iron, suitable for fixing to a wall. The length of the knife-edge is 100 mm. Each ... ... **3s. 0d.** $0.75 *d* *Logbook*

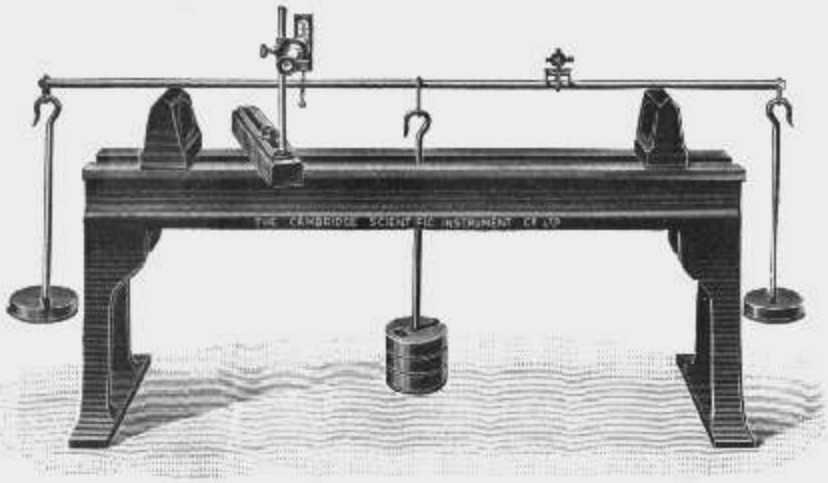
1114. Slotted Weights for use with Single Lever Testing Machine, No. 1103 E., etc.

	s.	d.	$	Code Word		s.	d.	$	Code Word
1 lb. each		9	0.18 *d*	*Incense*	0·5 Kilo, each	1	0	0.24 *d*	*Inbreed*
2 „ „	1	3	0.30 *d*	*Incensor*	1 „ „	1	3	0.30 *d*	*Incage*
5 „ „	2	6	0.60 *d*	*Inceptor*	2 „ „	2	6	0.60 *d*	*Incara*
10 „ „	4	6	1.10 *d*	*Incest*	5 „ „	5	0	1.20 *d*	*Incend*

1114 a. Hanger for carrying Slotted Weights. ... 3s. 0d. $0.72 *d* *Literalist*



No. 1116 E. $\frac{1}{11}$ full size.



No. 1116 E. $\frac{1}{14}$ full size.

1115. Elastic Bending of Rods, apparatus for observing. The rods can be supported as beams or as cantilevers and loaded at any point of their length. A small oil-cup can be attached at any point of the rod whose deflection is to be observed, the measurement being made by adjusting the point of a micrometer screw so as just to make contact with the oil. For reading the changes of tilt at any point of the rod, a spirit level, with compensating screw is used, the action being similar to that in No. 1104.

Complete with three rods of different sections. **£9. 0s. 0d.** **$43.80** *c* *Ireful*

1116 E. Lathe-bed Apparatus for Experiments on the Elastic Bending of Rods, whether arranged as beams or as cantilevers (see illustrations), up to 125 cms. long, and for measurements of Young's Modulus by bending, fitted with reading microscope having a micrometer eye-piece, and with jockey mirror for measuring the slope of the elastic curve with assortment of rods and weights. See Ewing's *Strength of Materials*, p. 83.

£19. 10s. 0d. **$95.00** *c* *Caustic*

1117. Apparatus for Determining the Deflection of Beams. This consists of two cast-iron brackets which can be fixed to a wall, an iron bed, two movable supports with knife edges,

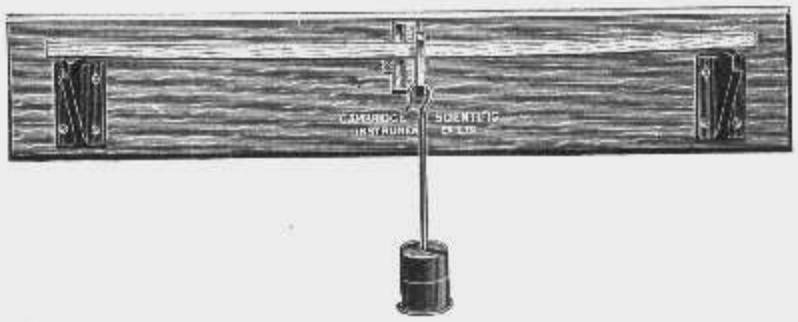
cast-iron block for use with cantilevers, stirrup, weight carrier, dial and pointer complete, as illustrated. ... ... **£6. 10s. 0d. $31.65** *d* *Celibacy*

See Perry's *Applied Mechanics* (Advanced), 1898 edition, p. 430.

No. 1117. ½ full size.

1117 a E. Apparatus for Deflection of Wooden Beams. Two knife-edge brackets are mounted as illustrated, and the beam to be investigated is laid across them. A load being applied centrally, the deflection produced is read off on a mirror-scale.

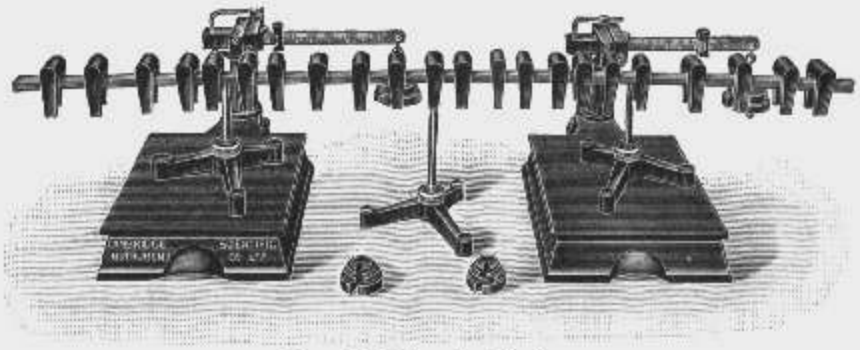
Complete with weights ... ... **£3. 0s. 0d. $14.40** *c* *Likeness*



No. 1117 a E. ½ full size.

1118 E. Continuous Beam Apparatus, with two platform balances and loaded beam, for experiments on the reaction at the supports of a continuous beam on three piers (see illustration).

£8. 10s. 0d. $41.40 *c* *Depressor*

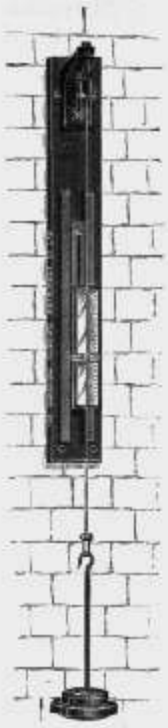


No. 1118 E. ⅛ full size.

1119 E. Apparatus for Measuring Extension of Wires to Rupture, for attachment to wall. With mirror, scale etc. (See illustration.) **£4. 5s. 0d. $20.70** *c* *Deterge*

1120. Apparatus for Observing Extension and Vibration of Springs, applicable to the measurement of "*g*," with reading pointer, celluloid scale on steel backing with two springs.

£3. 0s. 0d. $14.60 *d* *Literary*



No. 1119 E. $\frac{1}{2}\frac{1}{5}$ full size.

No. 1121 E. $\frac{1}{11}$ full size.

1121 E. Apparatus for Observing Extension and Vibration of Springs, applicable to the measurement of "*g*," with reading telescope, with two springs complete as illustrated.

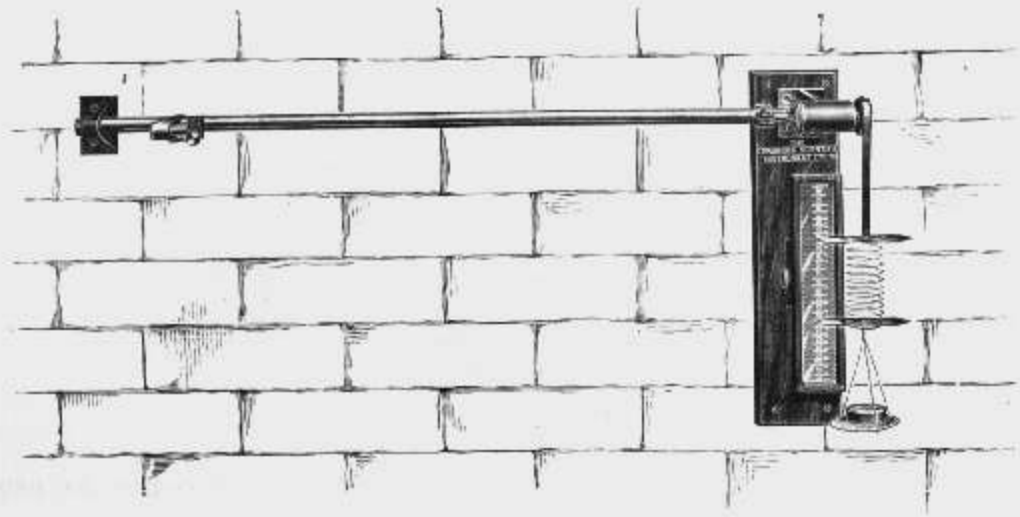
£6. 0s. 0d. $29.20 *c* *Deplore*

1122. Compression of Springs. An apparatus similar to Professor Perry's. The spring to be examined is placed in compression between a fixed bracket and a vertically guided cross-head which can be directly loaded; the corresponding compressions being read off to 0″·005 by means of scales and verniers. Two coiled steel springs and one rubber spring are provided.

£5. 0s. 0d. $24.35 *d* *Irrigate*

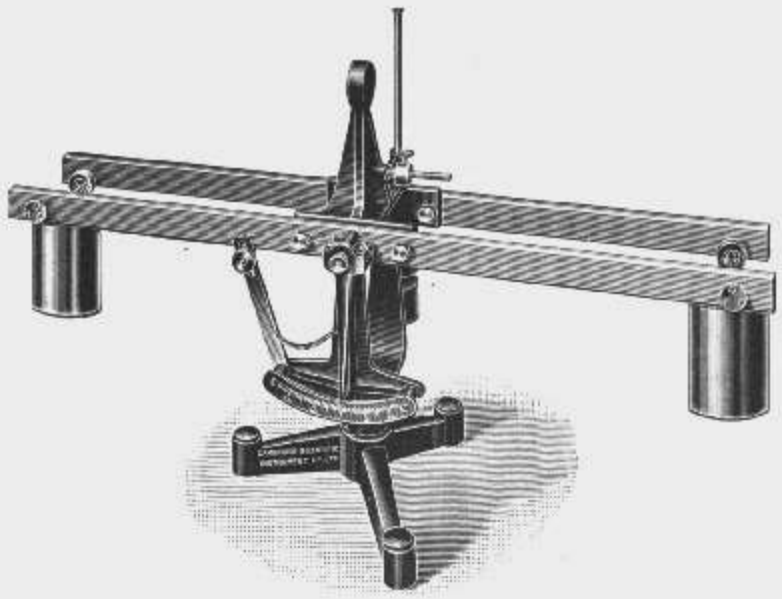
1123. Helical Springs, Apparatus for Demonstrating the Law of. Similar to that shown in Perry's *Applied Mechanics*, 1898 edition, p. 630. (See illustration.)

£3. 15s. 0d. $18.25 *c* *Censured*



No. 1123. $\frac{1}{1}\frac{1}{5}$ full size.

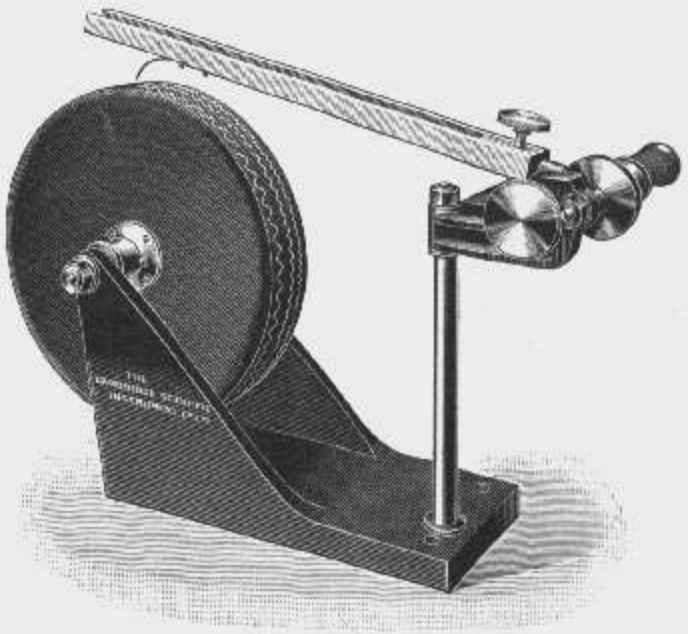
1124. Compound Ballistic Balance, for impact experiments with falling bodies. Of very substantial construction; the knife-edges being so constructed that the Balance is adapted for receiving either a vertical or horizontal blow and works without perceptible friction. To communicate a vertical blow two equal masses are placed in the Buckets which contain a little sawdust. One of the masses is then lifted out while the Beam is prevented by a catch from tilting. The mass so removed is then allowed to fall into the Bucket from a measured height and the deflection observed. ... ... **£10. 10s. 0d. $51.15** *c* *Lastage*



No. 1124. $\frac{1}{12}$ full size.

1125. Rotatory Inertia and Acceleration, apparatus for studying, similar to Professor Perry's form. A massive iron wheel is supported in plain bearings with its axis vertical, a cord wrapped round the axle of the wheel is passed over a fixed guide pulley and loaded. The circumference of the wheel is so marked that the instant when each half rotation is completed can be clearly observed. ... ... **£4. 15s. 0d. $23.15** *c* *Irrision*

1126 E. Heavy Fly-Wheel on Ball Bearings for acceleration experiments, with tuning fork attachment (see illustration). The pressure of the writing style is adjustable, and the fork can be displaced laterally. ... ... **£10. 0s. 0d. $48.70** *c* *Desumere*



No. 1126 E. $\frac{1}{4}$ full size.

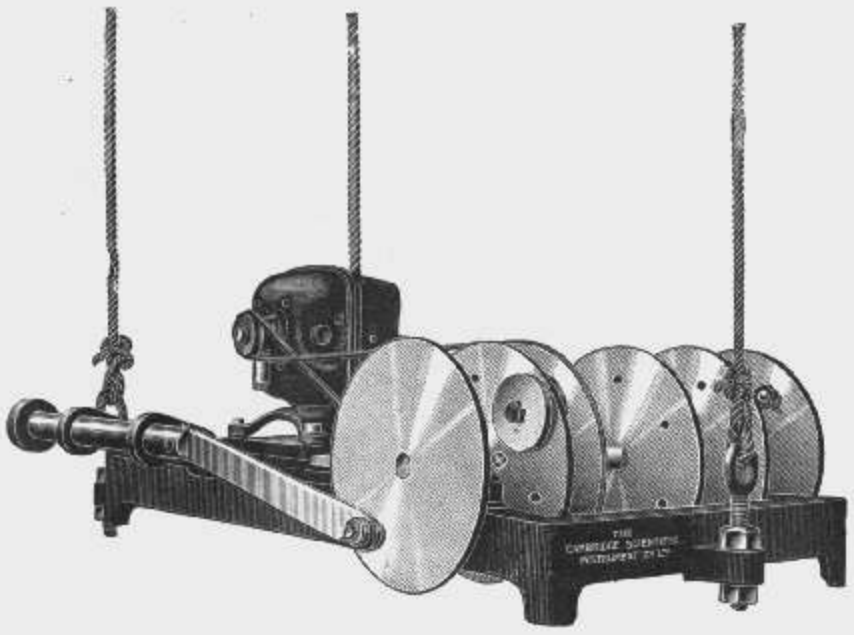
1127. Gyroscope, large pattern. The fly-wheel is 30 cms. in diameter and very massive; it is accurately balanced and runs on ball bearings. The construction is broadly similar to that of Lord Kelvin's Gyroscopes, a wheel and detachable belt being provided for spinning.

£10. 0s. 0d. $48.70 *c* *Lexicon*

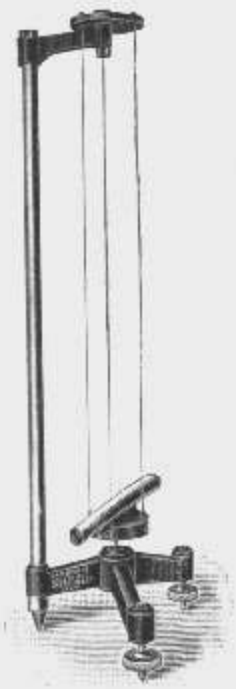
1128. Gyroscope, small pattern on gimbals, as illustrated.

£5. 0s. 0d. $24.35 *c* *Islet*

No. 1128. ⅛ full size.

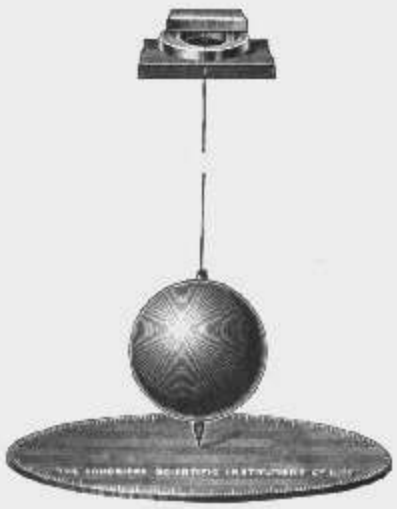


No. 1129. ⅛ full size.



No. 1131 a E. ⅛ full size.

No. 1133 E. ¼ full size.



No. 1134. ¼ full size.

1129. Apparatus for Experiments on the Balance of Revolving Machinery. In a frame which can be suspended, runs a shaft carrying 5 loaded discs and driven by an electric motor. The loads on the discs may be varied, as well as their angular positions and their distances apart. Two outside discs carry crank-pins from which loaded plungers are driven by means of connecting rods. Complete with electric motor, on cast iron base, as illustrated.

£20. 0s. 0d. $97.40 *d* *Desservir*

(When ordering, state for what voltage the motor is required; 120 or 240 volts.)

1130. Bifilar Suspension. A brass bar is fitted with six small hooks, any pair of which serves for the attachment of two ends of a wire, the middle of the wire being looped over any one of three semi-circular grooves in a fixed half-pulley. Thus the distance of the wires apart at either extremity can be varied and the inertia bar is always readily levelled. With stand.
£2. 0s. 0d. **$9.75** *c* *Isthmus*

1131 E. Bifilar Suspension, apparatus for experimental investigation of, using Maxwell's Needle. ... ... **£3. 15s. 0d.** **$18.25** *c* *Diamondize*

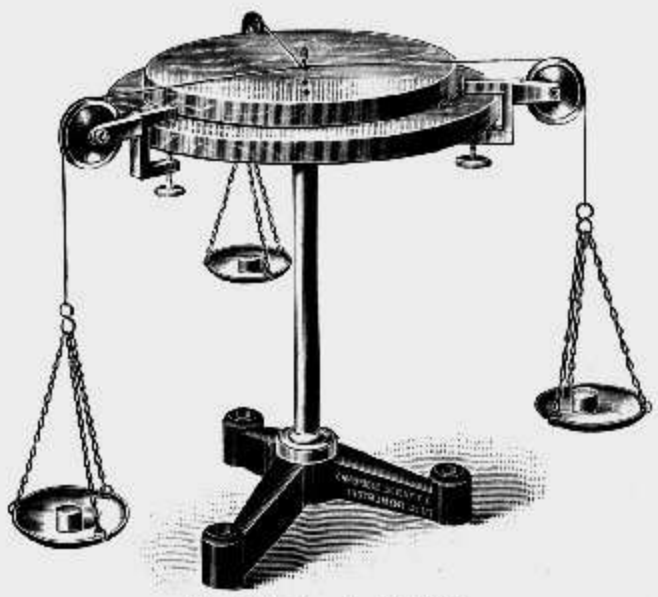
1131 a E. Trifilar Suspension, apparatus for investigation of, as illustrated.
£5. 5s. 0d. **$25.20** *c* *Lilac*

1132. Kater Pendulum, with adjustable bob, with wall-bracket carrying a plate, on which either knife edge is to turn. ... ... **£3. 0s. 0d.** **$14.60** *c* *Lithomancy*

1133 E. Compound Pendulum, Kater type, with adjustable bob, and fixed knife-edges, and with simple pendulum on the same stand (see illustration). A rod-pendulum (not figured) is also supplied. ... ... **£5. 0s. 0d.** **$24.35** *c* *Ivyed*

1134. Foucault's Pendulum (see illustration), for demonstrating the earth's rotation. The apparatus comprises a heavy cast iron ball with pointer adjustable lengthwise and clamp for holding the lower end of a supporting wire, a similar clamp carried on gimbals being provided for holding the upper end of the wire. The circular table, to be placed centrally beneath the pendulum, is divided in degrees, and a sliding piece (not shown) can be moved round the edge of the table and sighted in the plane of motion, its position being then read off. The point of suspension of the bob is a pole of that axis of figure which passes through the centre of gravity.
£3. 15s. 0d. **$18.25** *c* *Lictor*

1135 E. Composition of Moments, apparatus for experiments on the. Consisting of a horizontal table which is free to revolve about a vertical axis, and which takes up a position of equilibrium under the action of three moments produced by adjustable forces. (See illustration.)
£5. 0s. 0d. **$24.35** *Dieresis.*



No. 1135 E. $\frac{1}{10}$ full size.

1136. Hidden Gear, similar to that devised by Professor Perry, for illustrating the principle of virtual work. The student has access only to two cords hanging from the gear box, and by comparing their corresponding displacements, and the respective loads upon them which produce equilibrium, can verify the principle of virtual work. As constructed the ratios of the movement of the two pulleys are as 1 : 25. Perry's *Applied Mechanics*, 1898 edition, p. 58.
£2. 15s. 0d. **$13.40** *c* *Jacent*

1137. Screw Model, somewhat similar to Professor Perry's form. By means of equally loaded cords passing over guide pulleys, a couple is applied to a grooved pulley made fast on the spindle of a large vertical steel screw. The nut is restrained from rotation, and can be directly loaded, the limiting conditions of equilibrium being thus observable. Perry's *Applied Mechanics*, 1898 edition, p. 100. ... ... **£5. 0s. 0d.** $24.35 *c* *Jacobia*

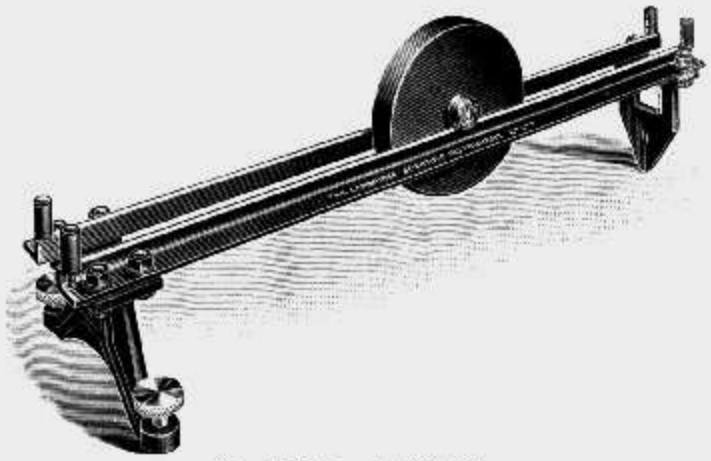
1138. Centrifugal Force Machine, for quantitative measurements of centrifugal force, a modified form of Prof. Perry's apparatus.

A weight is attached by means of a rod and lever to an iron diaphragm forming one side of a mercury reservoir. The system carrying the weight and reservoir is made to rotate by means of a pulley. As the speed of rotation is increased the mercury rises in the glass tube owing to the centrifugal force exerted by the brass weight. The distance of this weight from the centre can be varied as desired. A counter shows the number of revolutions made by the system. Without hand wheel. ... ... **£10. 0s. 0d.** $48.70 *c* *Jadery*

Hand wheel for driving the machine, on separate stand.
£1. 5s. 0d. $6.10 *c* *Janty*

1139. Centrifugal Force Machine. The force which has to be exerted upon a circularly moving bob to maintain its radial distance is supplied by a spring balance, and can be adjusted beforehand to a given value. The rotational movement is then imparted by hand, a counter being provided, as well as exact means for verifying that the parts controlled by the spring balance are in their standard position during the rotation. The bob can be set and clamped at varying distances from the axis of rotation. Complete. ... **£7. 0s. 0d.** $34.10 *c* *Jasmine*

1139 a. Apparatus for showing Moment of Momentum. This consists of a heavy cast iron fly-wheel with axle, the latter running on two parallel steel rails supported by cast iron feet. The weight of the wheel is approximately 3·4 kilos. and the diameter 15 cm. The rails are 2 metres long. ... ... **£3. 10s. 0d.** $17.00 *c* *Latitant*



No. 1139 a. $\frac{1}{20}$ full size.

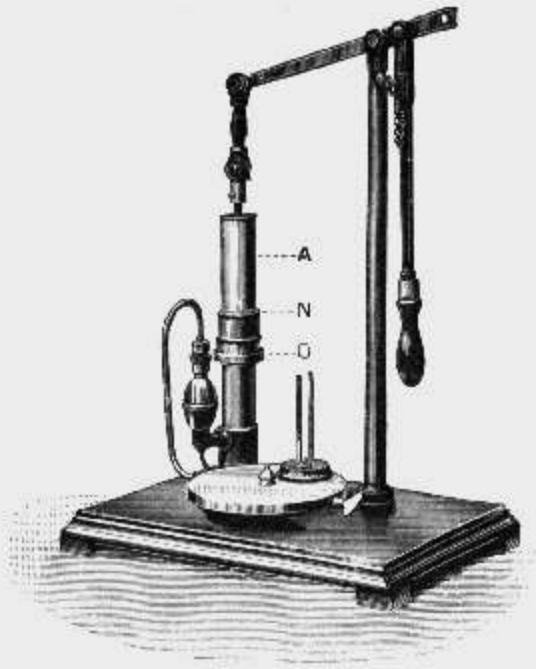
1140. Fleuss' Patent Vacuum Pump, single cylinder, with lever, "No. 1 size." (See illustration.) ... ... **£5. 0s. 0d.** $24.35 *a* *Centric*

1141. Do. do. with two cylinders and heavy fly-wheel "Duplex A." (See illustration.)
£20. 0s. 0d. $97.40 *a* *Gaol*

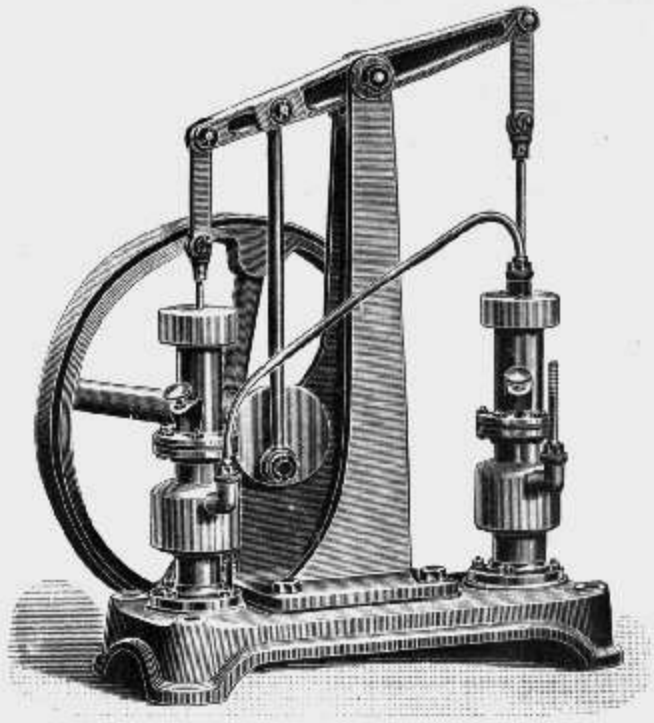
A V-shaped groove can be cut in the fly-wheel for driving with a motor.
Extra **7s. 6d.** $1.85 *a* *Lamprey*

1142. Large Receiver Plate, for vacuum experiments. The plate is of cast iron, accurately machined on the face, and is 35 cm. in diameter. It stands on three feet, which may be screwed to the bench, and is fitted with two nozzles for india-rubber pressure tubing, stop-cock, etc.
£5. 0s. 0d. $24.35 *c* *Languid*

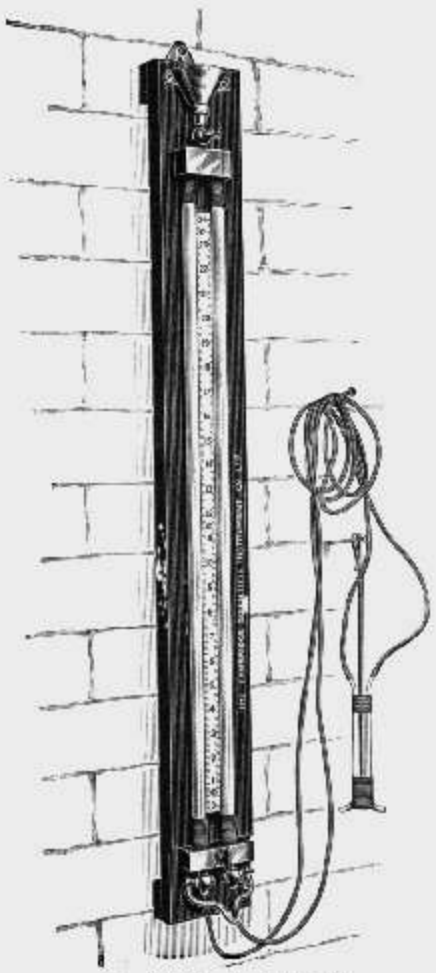
1143. Pitot-tubes. The illustration shows an outfit supplied to the Corporation of Manchester, to the design of the City Engineer, for determining the velocity of flow in sewers. Pitot-tubes with suitable gauges for pressure-difference are designed and constructed to fulfil specified requirements.



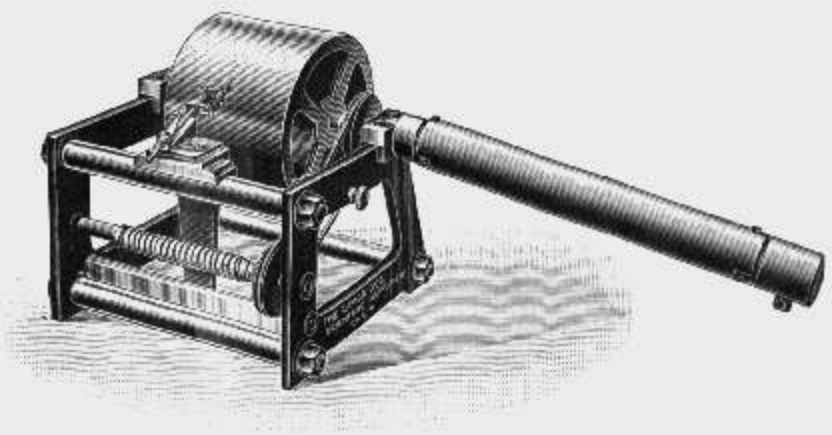
No. 1140. $\frac{1}{10}$ full size.



No. 1141. $\frac{1}{10}$ full size.



No. 1143. $\frac{1}{5}$ full size.



No. 1144. $\frac{1}{5}$ full size.

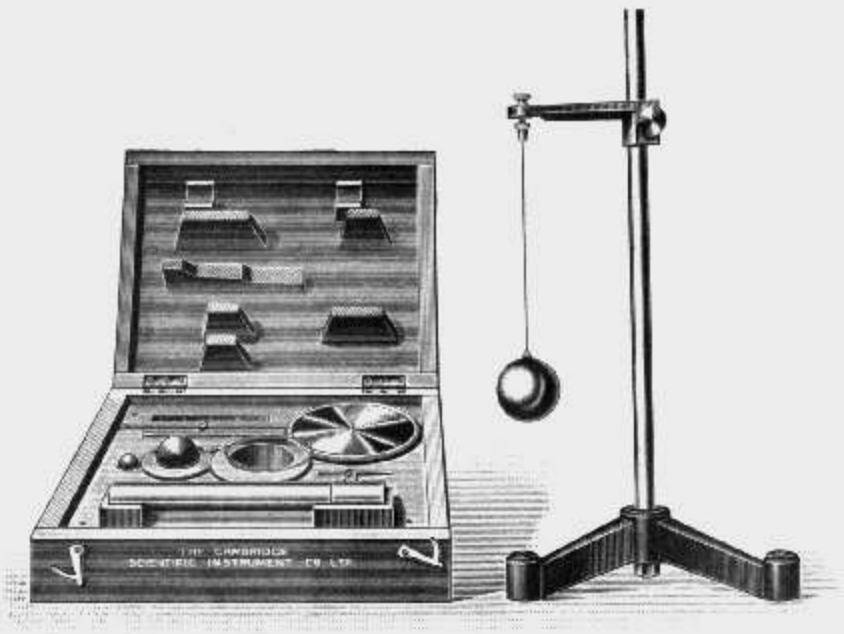
1144. Recorder for Variable Speed. A drum 160 mm. in diameter and covered with smoked paper, is connected by means of a short shaft and two universal joints specially designed to be free from backlash, to the rotating part of the machine under test. A vibrating tuning

fork is carried along the face of the drum by means of a screw. Convenient means are provided for simultaneously setting the fork vibrating, bringing the style on the fork into contact with the surface of the drum, and for giving it a lateral movement, causing it to trace a spiral. From the records obtained the variations in speed can be determined with great accuracy. As now constructed the screw moving the fork is driven positively from the shaft without the intermediary of the belt shown in the illustration. The edge of the drum is furnished with a divided circle and vernier, the interpretation of the records being thus rendered very convenient.

Price complete with tuning fork. ... ... **£26. 0s. 0d.** $124.80 *d* *Lither*

1145. Inertia Solids, designed by Mr C. V. Boys, F.R.S. Masses of brass and gunmetal of various accurate geometrical shapes, such as spheres, discs, tubes, etc., are so arranged that a small clamp may be fixed to various parts of them; they may thus be suspended, each in turn, from the end of a fine wire. Torsional oscillations being then set up, the moments of inertia may be compared by noting the periods of oscillation. Complete with stand as illustrated.

£4. 10s. 0d. $21.90 *c* *Gardyloo.*



No. 1145. ⅛ full size.

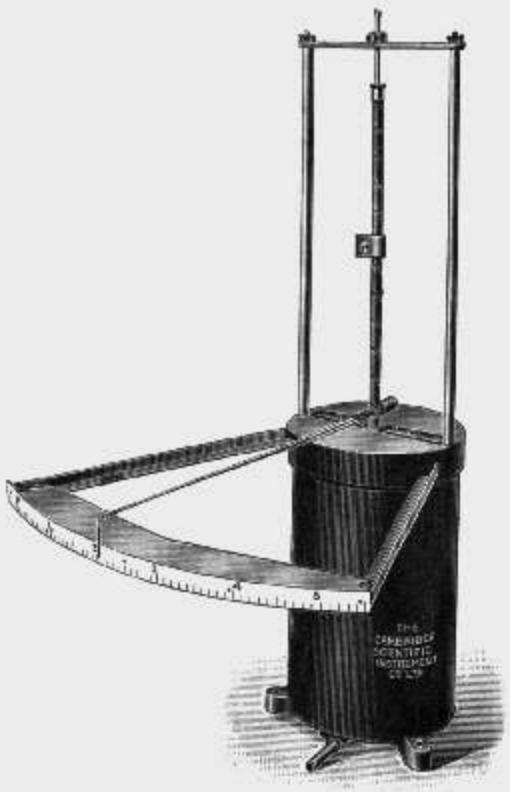
1146. Gas Pressure Gauge, for showing on an open scale the pressure of town-gas or the like (see illustration). Based on a design of Mr R. Threlfall, F.R.S. The figures on the scale correspond to inches of water.

£4. 10s. 0d. $21.90 *d* *Lanifice*

1147. Dead-weight Pressure Gauge. The pressure observed is transmitted by oil, and is measured in terms of the effective load on a cylindrical plunger, which fits in a cylinder freely without packing, and yet closely enough to prevent leakage of the oil. To ensure the almost complete elimination of friction, provision is made for producing a relative twisting motion between the plunger and the cylinder. Conveniently used in conjunction with the screw-pump No. 1150 for testing pressure gauges, etc., up to 4 tons per square inch.

Orders or enquiries for this apparatus should state the range of pressures in view.

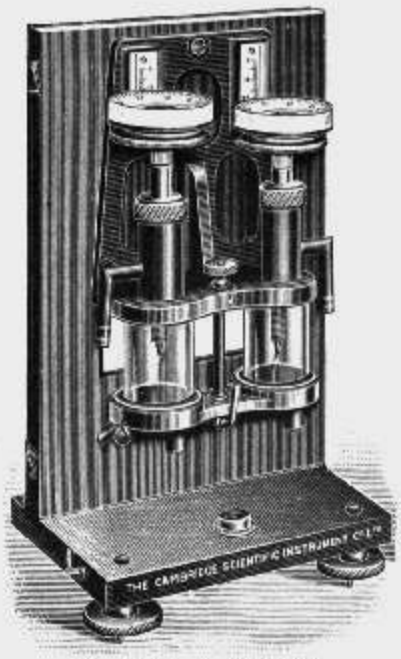
Price on application.



No. 1146. ⅛ full size.

1148. Micro-manometer, for measuring micrometrically differences of pressure up to about 25 mm. head of water. This instrument is based on a design by Mr R. Threlfall, F.R.S., its essential parts being in effect a U-tube containing water or oil and two micrometer screws whose points are adjusted to touch the free liquid surfaces in the limbs of the U-tube before readings are taken. If the air-spaces above the liquid in the two limbs are connected respectively to a Pitot-tube and side-gauge suitably fixed within a pipe conveying air or other gas, the velocity of the gas-stream is deducible from the observed difference of pressure. The instrument has been found useful for standardizing Mr Threlfall's stream-gauges. (See Stanton, *Minutes Proc. Civil Engineers*, Vol. 145; Threlfall, *Minutes of Proceedings Institution of Mechanical Engineers*, 1904; and *Journal of the Institute of Electrical Engineers*, Vol. 33, page 28.) As illustrated.

£9. 10s. 0d. **$46.30** *c* *Lanner*



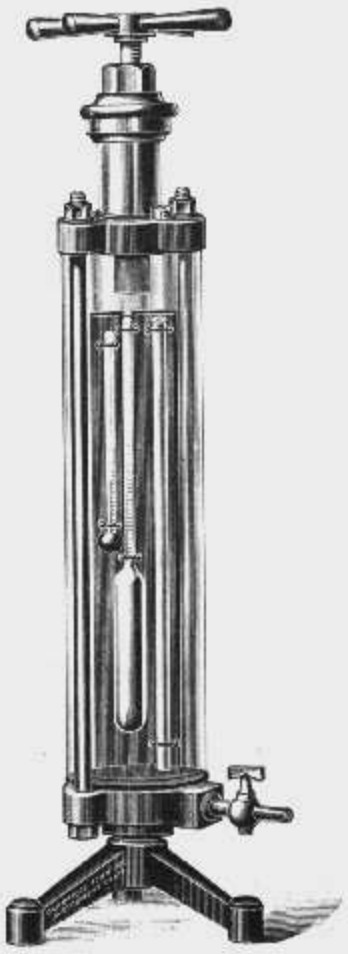
No. 1148. ½ full size.

1149. Pressure Gauges of Bourdon type for any pressure up to 32 tons per square inch (4000 atmospheres). Orders or enquiries should state for what use the gauges are intended, whether for water, compressed gas, or steam, etc.

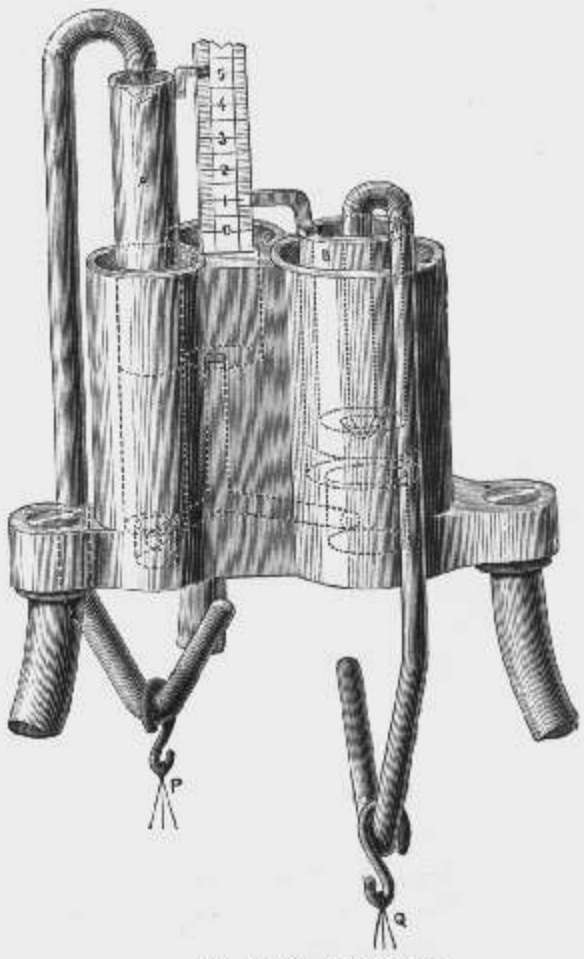
Prices furnished on specification of requirements.

1150. Screw-Pump. For maintaining a constant liquid pressure in any system where the leakage losses are small. Of very substantial construction, and serviceable for pressures up to 4 tons per square inch. For high-pressure work the hand-wheel is replaced by a larger star-handle.

With both hand-wheel and star-handle. ... **£22. 0s. 0d.** **$107.15** *c* *Lapling*



No. 1151. ⅛ full size.



No. 1153. ⅛ full size.

1151. Piezometer, a modification of Oersted's and Weinhold's forms; with screw plunger, fitting for Bourdon gauge, and safety valve, for working pressures up to 10 atmospheres, or specially constructed for higher pressures if desired. ... **£6. 0s. 0d.** $29.20 *c* *Lapper*

1152. Vacuum Gauge Tester. A short syphon barometer has its open limb bent downwards and ending in a taper plug. This plug can be inserted in a corresponding taper socket which may form part of the permanent fitting of an ordinary vacuum gauge, thus enabling the gauge to be readily tested in position. ... **£2. 10s. 0d.** $12.20 *d* *Lapwing*

1153. Hydrostatic Paradox. Apparatus for verifying the Transmissibility of Fluid Pressure. Two communicating cylinders are fitted with pistons, the face area of one being four times that of the other. Whatever "total pressure" acts on the smaller is exerted fourfold on the larger piston, if the fluid transmits the pressure equally to all parts. An index on each piston shows its rise or fall on a scale. On tripod stand complete. (See illustration.)
£5. 0s. 0d. $24.35 *d* *Caterwaul*

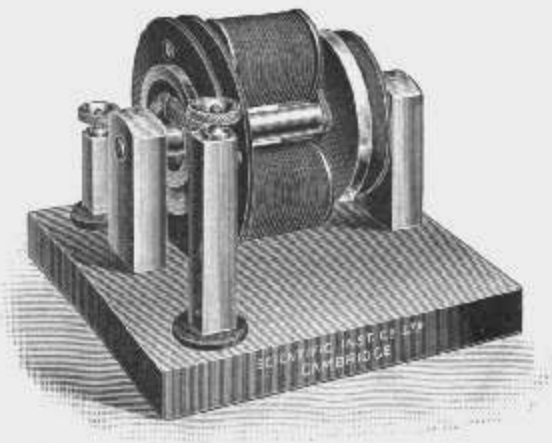
1154. U-tube, for studying the period and logarithmic decrement of oscillation of equilibrating columns of water. The tube is about 40 millimetres in diameter, and 80 centimetres in height, and is mounted on a wooden support. Boxwood scales divided in millimetres are provided for reading the level of the water in the tubes. ... ... **£2. 0s. 0d.** $9.75 *c* *Larkspur*

1155. Viscosity Apparatus, similar to Professor Perry's form. Within a shallow cylindrical drum, whose axis is vertical, is a somewhat smaller drum, the interspace being filled with the liquid to be investigated. The inner drum is suspended by a vertical wire, about which as an axis it can oscillate, the damping of the oscillations being proportional to the viscosity of the liquid. Thus the viscosities of different liquids can be compared. It is a convenient arrangement to have, say, three of these instruments permanently set up side by side, and filled with different liquids, such as water, oil and glycerine. See Perry's *Applied Mechanics*, 1901 edition, p. 77.

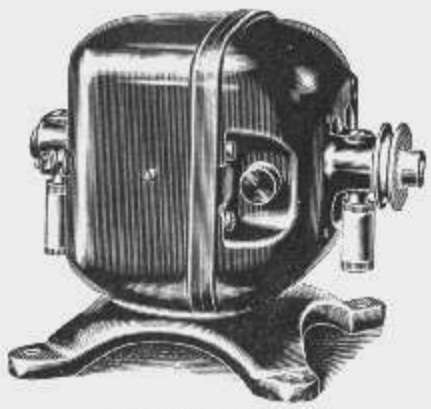
Price of the single instrument: complete with pointer and divided circle, mounted on substantial iron stand. ... ... **£5. 0s. 0d.** $24.00 *c* *Litigious*

1156. Magnetic Clutch, for instantly throwing a pump or any other piece of mechanism in or out of gear. A soft iron pulley may be continuously driven, and when the clutch is excited the pulley to which the pump is connected is gripped magnetically and caused to revolve. (See illustration.) ... ... **£4. 0s. 0d.** $19.50 *d* *Bakehouse*

When ordering please state the voltage on which the clutch is to be used.



No. 1156. ⅓ full size.



No. 1157. ¼ full size.

1157. Electric Motors, $\frac{1}{10}$ H.P. shunt wound, iron clad, approximate speed 2400 revolutions per minute, with $1\frac{1}{4}$ inch V-pulley, weight $18\frac{1}{2}$ lbs. (See illustration.)

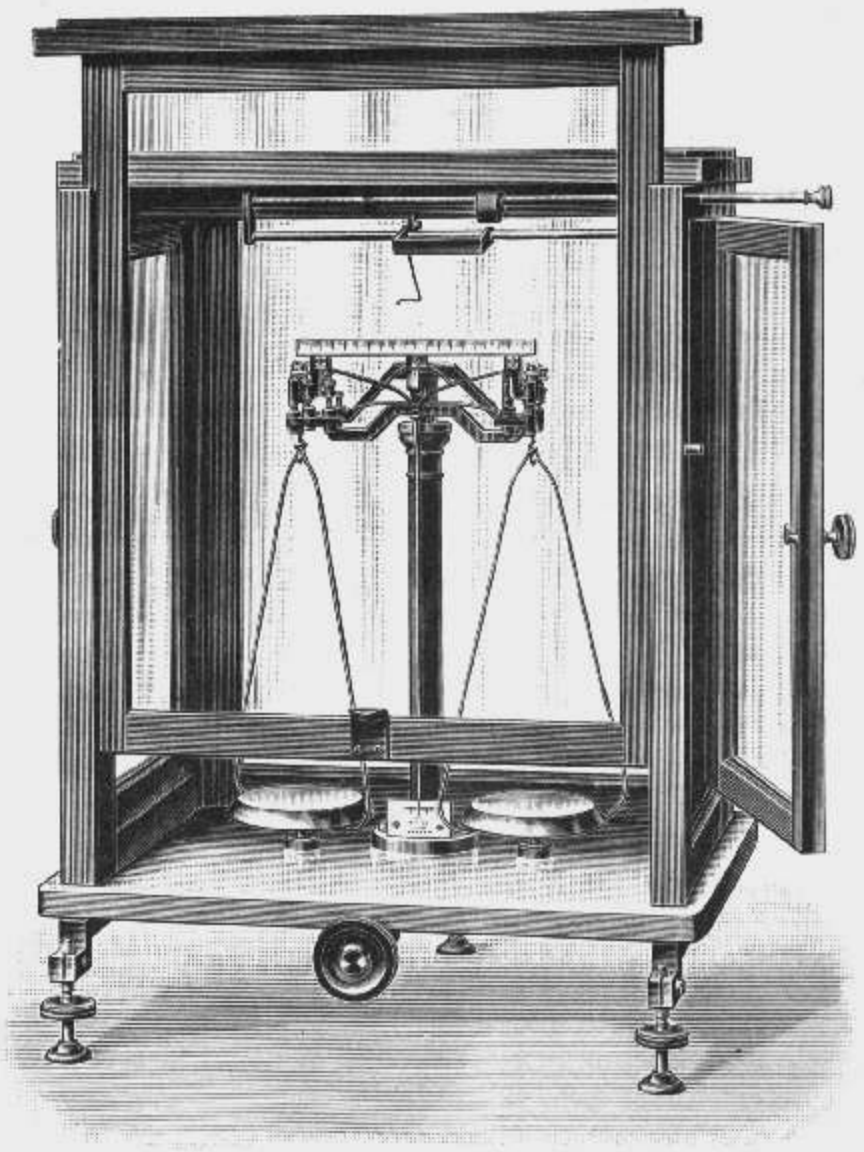
For 100—110 volts.	**£3. 0s. 0d.**	$14.60 *b*	*Larva*
For 200—250 volts.	**£3. 12s. 0d.**	$17.50 *b*	*Larynx*

Motors of any capacity and for any voltage supplied to order.

§ 5. BALANCES AND WEIGHTS.

1200. Short Beam Balances for accurate and rapid weighing. Beam of phosphor-bronze or aluminium, circular form of arrestment, adjustable knife edges, and parallel rider adjustment. Platinised scales, knife-edges and planes of agate. Base of balance-case of black glass. (See illustration.)

Sensibility	Maximum load	Price	$	Code Word
1·0 mgrm.	2000 grams	£22. 10s. 0d.	109.60 *b*	*Launder*
0·2 „	1000 „	£18. 15s. 0d.	91.30 *b*	*Laureate*
0·15 „	500 „	£14. 0s. 0d.	68.20 *b*	*Lavation*
0·10 „	200 „	£11. 0s. 0d.	53.60 *b*	*Laveer*
0·10 „	100 „	£11. 0s. 0d.	53.60 *b*	*Laverock*



No. 1200. $\frac{1}{10}$ full size.

1201. Assay Balance with long beam of aluminium-silver alloy, arrestment for beam and scale pans; silver scale. The floor of the balance-case is of black glass, the glass front is counter-balanced. Parallel rider adjustment. Lens (not shown) for reading the indications of the pointer. Sensibility ·005 milligram. ... ... **£17. 10s. 0d.** **$85.20** *b* *Lavisher*

1202. Assay Balance, similar to the above, but with short beam for rapid weighing; sensibility 0·01 milligram. ... ... **£13. 15s. 0d.** **$67.00** *b* *Lavolta*

1203. Simple Assay Balance, complete with arrestment, in walnut and glass case; sensibility 0·1 milligram. ... ... **£5. 15s. 0d.** $28.00 *b* *Lawless*

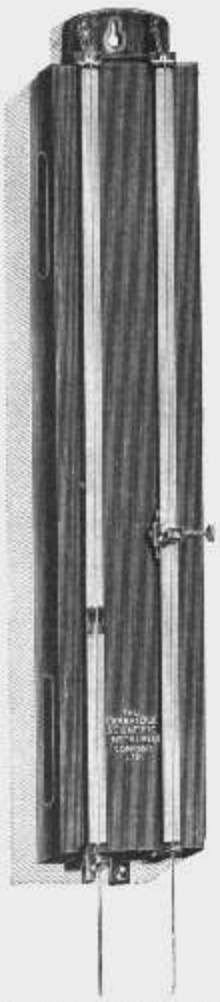
1204. Weights, heavily gilt or platinised, and accurately adjusted, in case. Those below 1 gram are of platinum, and are covered by a glass plate. Ivory tipped forceps are provided.

From 1 milligram to	Gilt	$	Code Word	Platinised	$	Code Word
10 grams	19s. 0d.	4.65	*Lawday*	£1. 1s. 0d.	5.10 *b*	*Leafy*
20 ,,	£1. 1s. 0d.	5.10	*Lawny*	£1. 3s. 6d.	5.70 *b*	*Leaguer*
50 ,,	£1. 5s. 0d.	6.10	*Laxative*	£1. 8s. 0d.	6.85 *b*	*Leaper*
100 ,,	£1. 9s. 0d.	7.10	*Laxness*	£1. 12s. 6d.	7.90 *b*	*Leapfrog*
200 ,,	£2. 0s. 0d.	9.75	*Layman*	£2. 3s. 0d.	10.50 *b*	*Leapyear*
500 ,,	£2. 10s. 0d.	12.20	*Lazar*	£2. 15s. 0d.	13.40 *b*	*Leasing*
1000 ,,	£3. 10s. 0d.	17.00	*Leafless*	£3. 18s. 0d.	19.00 *b*	*Leavenous*

§ 6. SOUND.

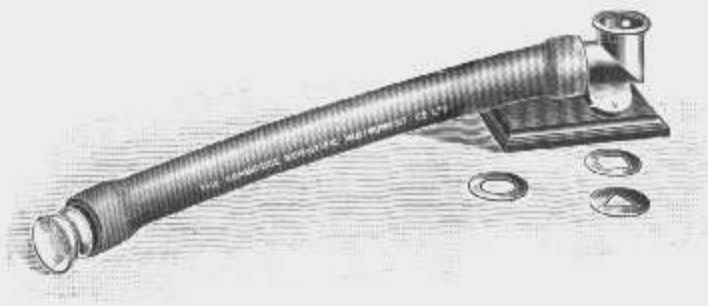
1225. Sonometer, vertical type. Made for fixing to a wall. Two wires can be loaded independently by weights, and in each case the lower end of the vibrating length can be unclamped and reclamped while the wire is under tension, frictional error being thus completely eliminated from the estimation of the stretching force.

For one wire an intermediate bridge is provided, which can be moved and clamped; for the other wire a narrow-edged felt damper, also capable of being moved and clamped. Two carriers for slotted weights are provided. (See illustration.) ... ... **£4. 10s. 0d.** $21.90 *c* *Liturgy*



No. 1225. $\frac{1}{11}$ full size.

1226. Resonance tubes of adjustable length. Two vertical glass tubes about one metre long are fixed to two boards with their open mouths upwards. These can slide up and down and can be clamped in any position. Their lower ends are connected by a flexible indiarubber tube. When the tubes are partially filled with water their effective length can be readily altered by raising or lowering one of them. A scale is fixed behind each tube, in order that the distance of the surface of the water from the open mouth of the tube can be obtained. ... ... **£2. 10s. 0d.** $12.20 *d* *Chatoyant*



No. 1227. $\frac{1}{2}$ full size.

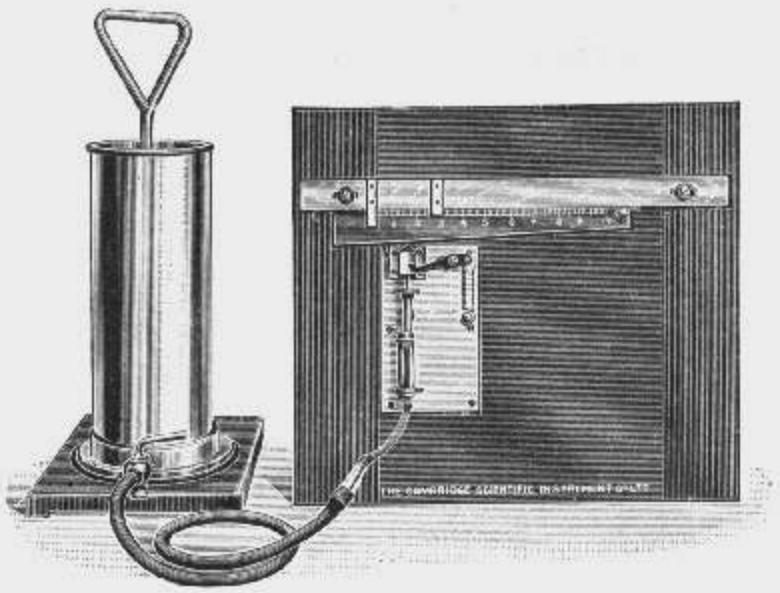
1227. Phoneidoscope. Devised by Mr Sedley Taylor for observing the coloured figures reflected from thin liquid films in sonorous vibration. There are three metal discs, pierced respectively by triangular, square and circular apertures across which flat soap-sud films may be formed. (See illustration.) ... ... **15s. 6d.** $3.80 *d* *Chastely*

1228. Galton's Whistle. This is a whistle of very small bore, whose length can be varied by an adjustable plug. The whistle is sounded by squeezing air out of a small indiarubber bag. When testing for the highest audible note the whistle is sounded and the length of its pipe

shortened, until a point is reached when the note becomes inaudible. The length of the whistle is then measured by a wedge-shaped ivory scale, the numbers engraved upon the scale giving the pipe-length of the whistle in millimetres. (See "On the Notes sounded by Mr Galton's Whistles for Testing the limit of Audibility of Sound," by W. N. Shaw, M.A., *Journal of the Anthropological Institute*, November, 1887.)

Adjustable whistle alone, in case. ... ... **£1. 0s. 0d.** **$4.90** *c* *Belauded*

With blower and arrangement for accurately reading the length of the whistle as illustrated.
£6. 10s. 0d. **$31.65** *c* *Belfries*

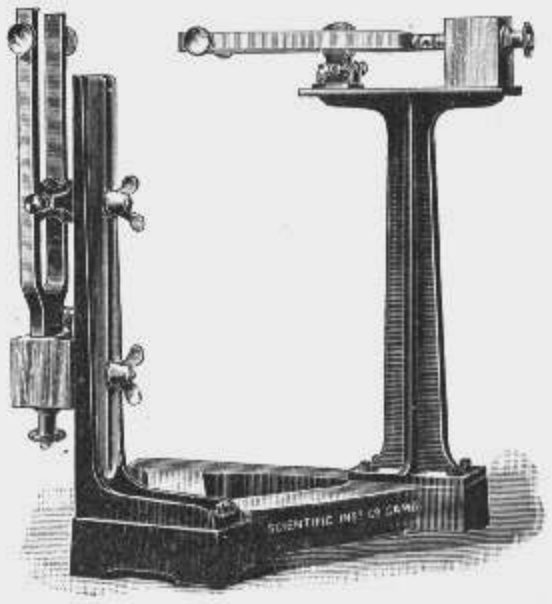


No. 1228. ⅓ full size.

1229. Tuning Fork Apparatus for producing Lissajou's Figures. This consists of two tuning forks, one horizontal and the other vertical, both carrying small mirrors. The forks are mounted as shown in the illustration and are maintained in vibration by means of electro-magnets.

Stand without forks, but including electro-magnets.
£9. 0s. 0d. **$43.85** *c* *Chatwood*

Apparatus complete with two calibrated forks carrying mirrors. Unless ordered to the contrary, forks having frequencies as 1 : 2 will be supplied.
£15. 0s. 0d. **$73.00** *c* *Chebako*



No. 1229. ¼ full size.

1229 a. Lissajou's Figures, simple apparatus for showing. The vibrating body is a thin bar, whose effective elasticity is in general different for two principle flexures, so that the frequency is different for the two corresponding directions of vibration. The free end carries a mirror in which any bright point is viewed, or by reflection at which a point of light is projected on a screen. The movement of the image (virtual or real) traces Lissajou's figures, the ratio being continuously adjustable through a wide range, commencing with a ratio of equality.
£1. 10s. 0d. **$7.30** *d* *Lection*

1230. Organ Bellows, for supplying wind to organ-pipes, sirens, etc.; of large capacity, and giving a very steady blast when suitably loaded. Price on application.

1231. Flame-manometer, for use with a rotating mirror (see No. 1233) for detecting and analysing aerial vibrations. As illustrated. ... **15s. 0d.** **$3.65** *c* *Leeward*

1232. Koenig's Pipe for showing the nodes of vibrations; provided with three gas flame manometers, as illustrated. ... ... **£2. 10s. 0d.** **$12.20** *c* *Chevying*

1233. Rotating Mirror on Stand (see illustration). This may be turned by hand, or driven by a cord passing over the grooved pulley. ... **£2. 0s. 0d.** **$9.75** *c* *Chidingly*

No. 1231. ⅔ full size.

No. 1232. $\frac{1}{10}$ full size.

No. 1233. ⅓ full size.

1234. Precision Syren, for the accurate determination of pitch or vibration-frequency. Two rows of holes are provided, the numbers of holes in the rows being as ten to one. The speed is adjusted by means of a sensitive friction governor by which it can be maintained accurately constant independently of the strength of the air blast. A counter can be instantly thrown into or out of gear with the spindle of the syren.

£15. 0s. 0d. **$73.00** *c* *Leeringly*

1235. Kundt's Apparatus. For producing dust figures in a glass tube to show the nodes and loops, and for finding the velocity of sound in air or other gases (see illustration).

£5. 0s. 0d. **$24.35** *d* *Chiphat*

No. 1235. $\frac{1}{12}$ full size.

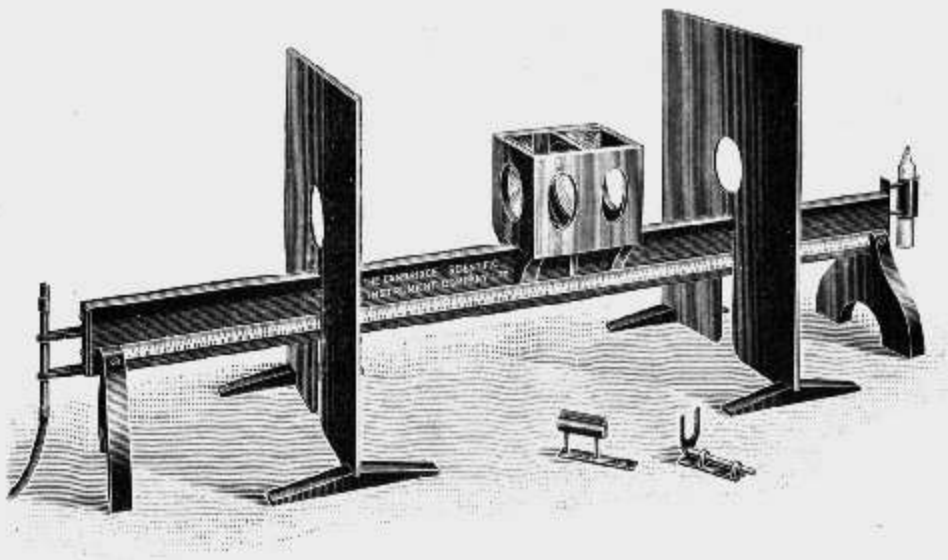
1236. Resonator with Adjustable Mouth. The resonator is a glass vessel covered by a brass plate with an aperture of adjustable size. A scale shows the length of aperture in milli metres. The vessel may be partly filled with water, thus varying the volume of the resonator.

12s. 6d. **$3.05** *c* *Girrock*

§ 7. LIGHT.

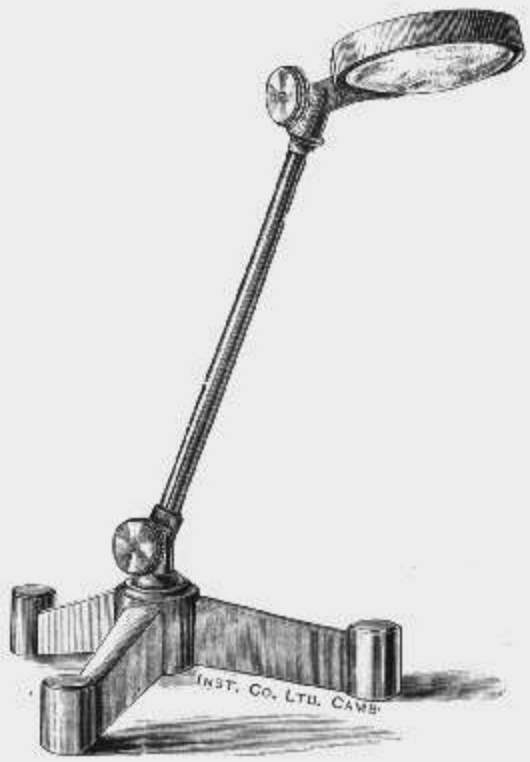
1260. Bunsen Photometer, for laboratory use. A horizontal bar of mahogany carries a boxwood scale. A sight-box mounted on a carriage carrying a pointer is movable along the bar. Distance between lights 120 cms. Holders are provided for a standard candle, an electric lamp, and a gas burner. Two shade screens are provided. Complete, as illustrated.

£6. 10s. 0d. **$31.65** *d* *Chirurgeon*



No. 1260. $\frac{1}{7}$ full size.

1261. Condensing Lens. The plano-convex lens, 75 mm. in diameter and 75 mm. in focal length, can be fixed in any required position by clamping the joints in the arm. The base is a cast-iron tripod (see illustration). ... ... **£1. 15s. 0d.** **$8.50** *d* *Gastromyth*



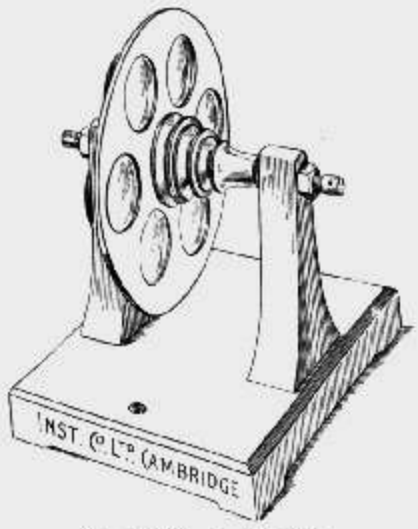
No. 1261. $\frac{1}{4}$ full size.

1262. Optical Lantern with specially rigid hand-feed arc lamp, in Russian iron case.

£10. 0s. 0d. **$48.00** *d* *Limbeck*

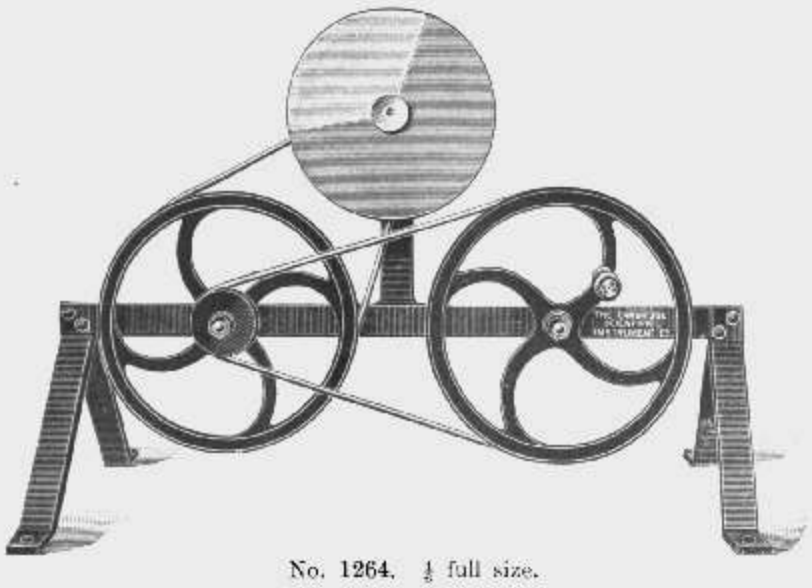
1263. Wheel of Lenses, for analysing the oscillations of an electric spark. The wheel is a brass disc containing six achromatic lenses of about 150 mm. focal length. The lenses are arranged in three pairs, each pair being opposite one another and equidistant from the axis, while the axial distances of the three respective pairs differ slightly from one another. The image of the oscillating spark, focussed by the rapidly revolving wheel upon a screen or photographic plate, is drawn out into a beaded form. If the plate is large enough to take an arc of 60°, the whole record of the spark will be found upon it. A pulley with V-grooves is provided on the spindle by means of which the wheel may be rotated. See "Notes on the Oscillating Electric Spark," by C. V. Boys, F.R.S., in the *Phil. Mag.* of Sept. 1890. As illustrated.

£4. 15s. 0d. $23.15 *d* *Choiceful*



No. 1263. ¼ full size.

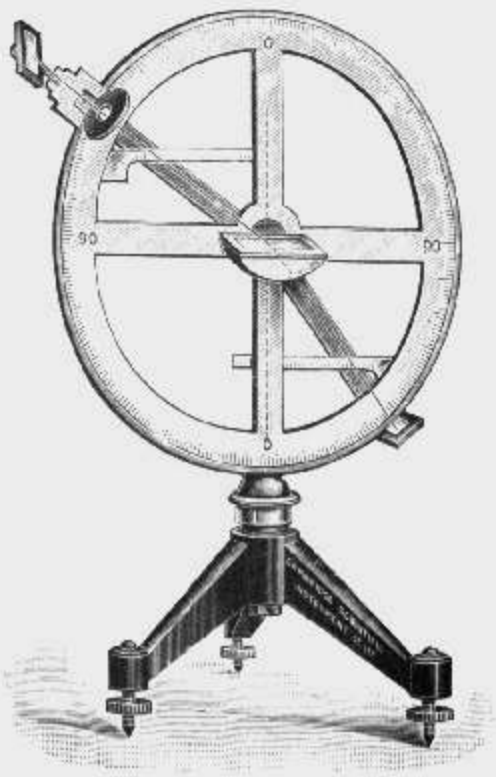
1264. Colour Mixer (see illustration). Coloured discs of paper of the standard tints adopted by Prof. Hering are supplied with the instrument, and the different colours can be mixed in varying proportions. A smaller central disc of one colour can be fixed in front of the coloured sectors, to serve as a standard for matching. **£3. 0s. 0d.** $14.60 *c* *Bardic*



No. 1264. ¼ full size.

1265. Laws of Reflection and Refraction, Apparatus for Demonstrating. A vertical graduated metal circle is furnished with two arms which can be set at any angle. One arm carries a mirror which reflects light from a source either on to another mirror, or on to a liquid placed in a glass trough which can be fixed at the centre of the divided circle. Two horizontal scales are also attached to the instrument in order that the sines of the incident and refracting angles can be compared. On cast-iron stand with levelling screws (see illustration).

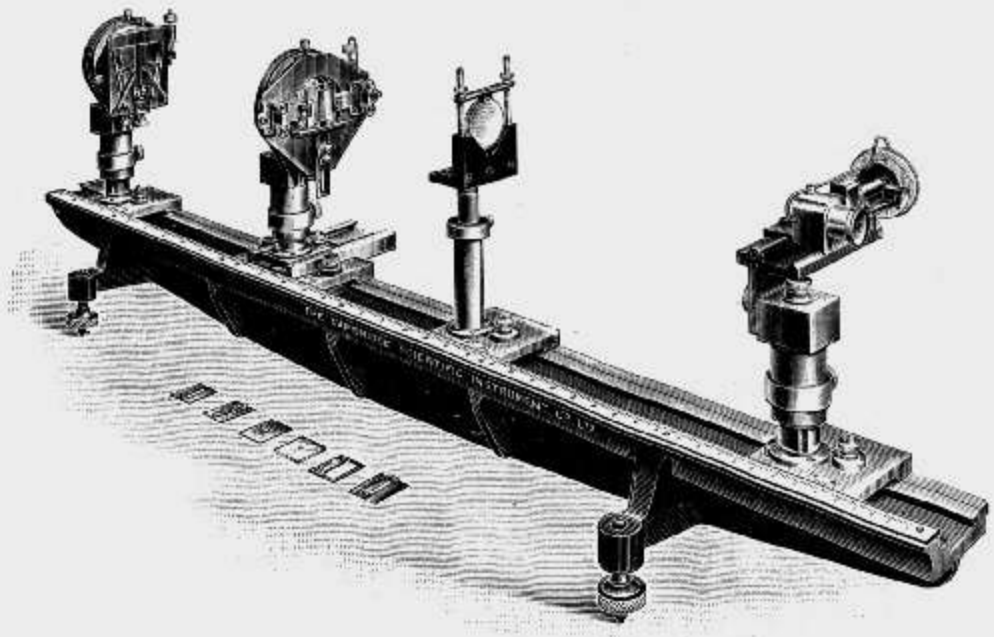
£7. 0s. 0d. $34.10 *c* *Chokeberry*



No. 1265. ¼ full size.

1266. Optical Bench (see illustration). The bed is of cast-iron and very rigid. On the ways, which are scraped true, the pillar-blocks can be slid and clamped geometrically. The three main pillars are adjustable vertically by open-pitched screws, and have geometric clamping. Two swivelling cells with clamp and slow-motion are provided for these pillars, one of which is adjustable transversely to the bed. The Fresnel eye-piece has a micrometer head reading directly to ·005 mm. The bench is supplied with a fourth pillar carrying a lens holder, one slit with self-centring adjustment, seven slides for diffraction experiments, Fresnel bi-prism, electric incandescent lamp, and gas burner.

£50. 0s. 0d. $243.50 *c* *Legatary*



No. 1266. $\frac{1}{10}$ full size.

Prices for accessories for use with the above quoted on application.

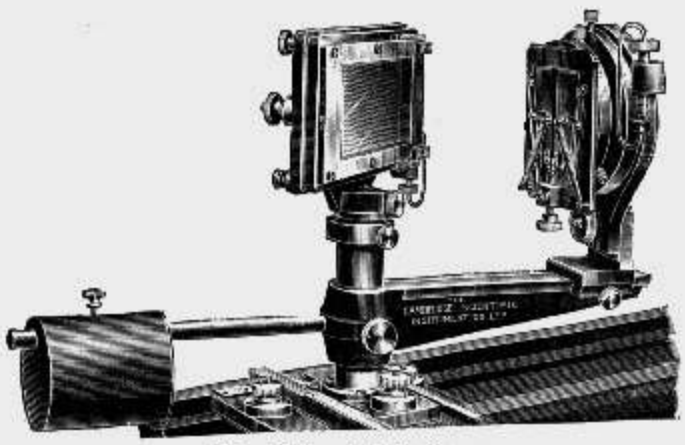
1267. Fresnel Mirrors, of black glass. The reflecting faces extend up to their line of intersection, and the swivelling of the adjustable mirror takes place precisely about that line. This involves no tedious adjustment, but is secured automatically. One of the mirrors can be tilted by means of a micrometer screw of half-millimetre pitch with divided head.

On special attachment for fixing upon the optical bench, No. 1226.

£14. 0s. 0d. $68.20 *c* *Legalize*

The illustration shows this attachment supporting the mirrors, and also carrying the slit with self-centring adjustment.

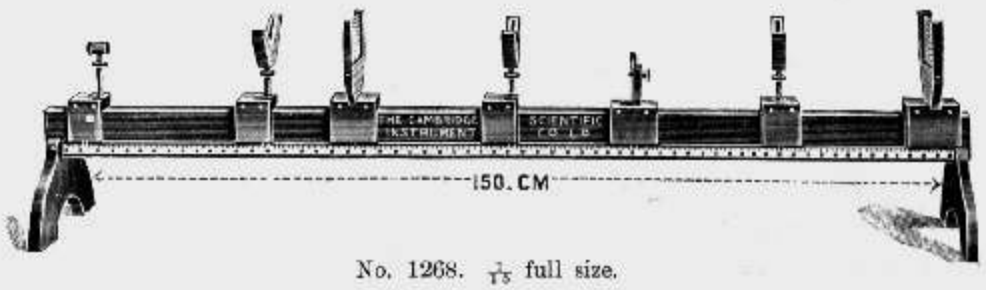
On separate stand. ... ... **£10. 0s. 0d. $48.70** *c* *Legist*



No. 1267. $\frac{1}{8}$ full size.

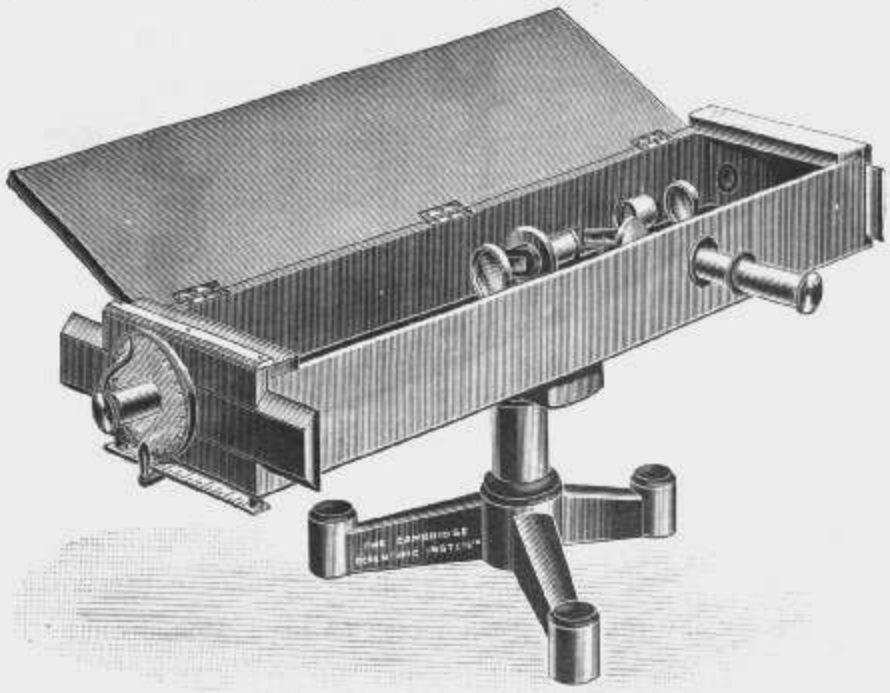
1268. Optical Bench, Students' pattern (see illustration). The bed is of mahogany and has a millimetre scale throughout its length. Carriers are provided, an eye-piece with cross wires, a wire screen, opaque and ground glass screens, a gas burner, and set of lenses.

£6. 0s. 0d. $29.20 *d* *Gelable*

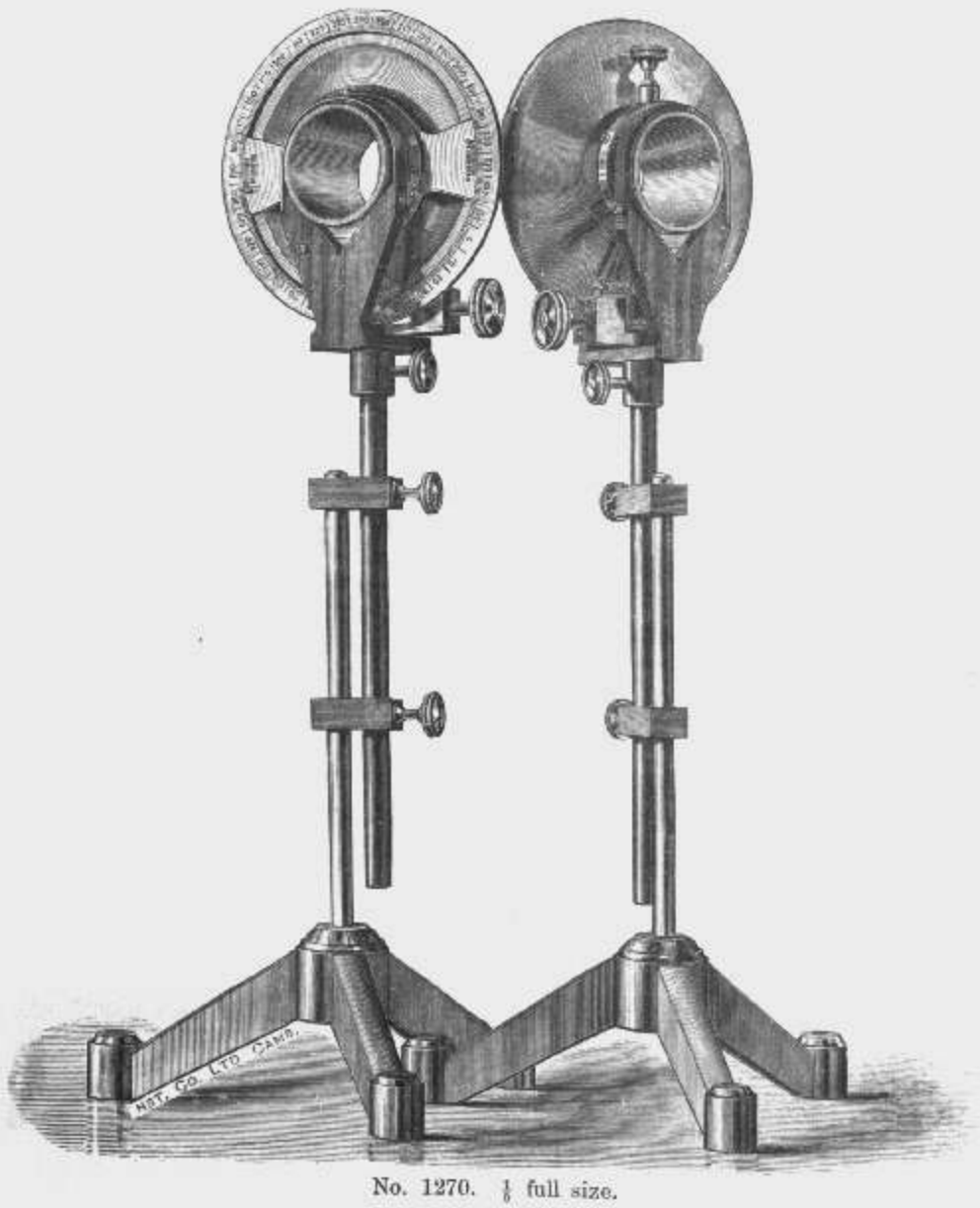


No. 1268. $\frac{1}{15}$ full size.

1269. Spectrophotometer (see illustration). A modification of the colour-box of Clerk Maxwell, which may be used for three purposes of physical and physiological interest.



No. 1269. ¼ full size.



No. 1270. ⅛ full size.

I. *As a Spectrophotometer.* By means of an appropriate arrangement of prisms, lenses, and slits, two superposed polarised spectra are produced, any desired colour from which may be observed through an analysing Nicol. By rotating the Nicols the brightness of these portions of the spectra may be widely varied and thus the loss of intensity of light on passing through an absorbing medium may be found.

II. *As a means of detecting and estimating colour-blindness.* The light which yields one of the spectra falls, before passing through the prism, upon a mirror, by rotating which any one portion of one spectrum can be placed in juxtaposition with any other portion.

III. *As a means of matching mixed spectral colours with any one colour of a pure spectrum.* By a proper adjustment of a double image prism, any two colours of one spectrum can be seen as mixed, and by rotating the mirror, any portion of the other spectrum can be compared with the mixed colours. (See an article in *Nature*, Nov. 17, 1881, by Lord Rayleigh, and in the *Journal of Physiology*, Vol. v. Part 6, by Dr Sheridan Lea.)

£13. 10s. 0d. $65.75 *c* *Barberry*

1270. Polariscope, Stand for. For holding any optical piece, and rotating it about the line of vision through angles which can be read to one minute of arc by means of verniers. Vertically adjustable on heavy tripod foot. ... £10. 0s. 0d. $48.70 *c* *Chokepear*

Per pair (see illustration). ... ... £18. 10s. 0d. $90.10 *c* *Gavial*

1271. Nicol Prisms, unmounted.

	£	*s.*	*d.*	$	
6 mm. Aperture.		7	0	1.70 *b*	*Lenten*
9 mm. ,, ...		11	6	2.80 *b*	*Lentisk*
12 mm. ,, ...		19	0	4.65 *b*	*Leonine*
15 mm. ,, ...	1	15	0	8.50 *b*	*Limber*
20 mm. ,, ...	4	10	0	21.90 *b*	*Lepid*
25 mm. ,, ...	12	0	0	58.45 *b*	*Lethal*
30 mm. ,, ...	20	0	0	97.40 *b*	*Lethargy*

Larger sizes to order.

1272. Laboratory Spectrometer, of exceptionally rigid design. Adjustable slit, with comparison prism; collimator and telescope are of 25 mm. clear aperture and have full collimation adjustments. Telescope has clamp and slow motion in azimuth, with vernier reading to one minute on a circle 164 mm. in diameter.

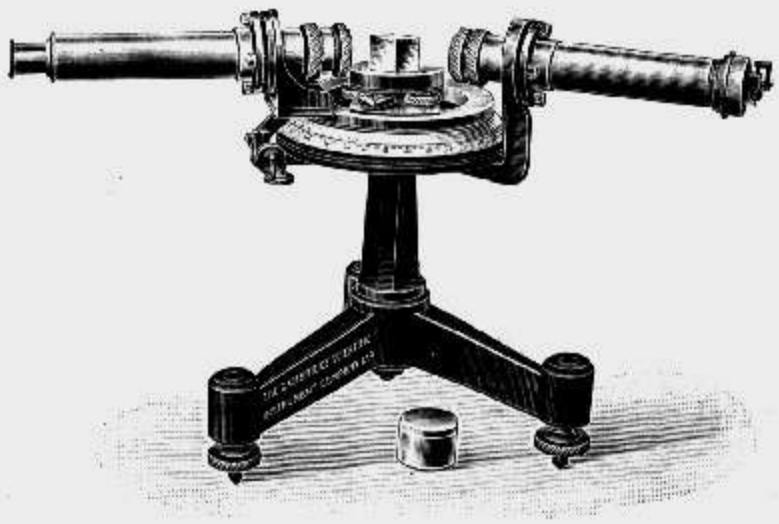
The collimation of the telescope cannot be disturbed by focussing the eyepiece.

Prism table with independent levelling screws mounted on azimuth circle reading in degrees.

Price complete, as illustrated, with flint prism of 35 mm. face.

£16. 0s. 0d. $77.90 *d* *Balloter*

Without prism ... ... £15. 0s. 0d. $73.00 *d* *Ballotade*



No. 1272. ⅓ full size.

1273. Laboratory Spectrometer, similar to the above, but with telescope and collimator of 38 mm. aperture, and 200 mm. circle, with four verniers reading to one minute of arc, prism circle with one vernier reading to five minutes, without prism.

£20. 0s. 0d. $97.40 *d* *Legatine*

1274. Spectrometer Table and Telescope Supports. The table is of cast-iron, circular and 400 mm. in diameter. It is provided with a circular V-groove, which serves for the geometric guiding of the supports, upon which any telescope and collimator can be readily set up, a prism table is provided. For comparison work on spectra and for students' use.

Since we first introduced this apparatus many years ago, it has proved itself very convenient for a variety of uses. ... ... **£7. 10s. 0d.** $36.50 *d* *Legendary*

Price including telescope with object glass 25 mm. in diameter, collimator and slit.

£12. 10s. 0d. $60.90 *d* *Leger*

1275. Right Angle Prisms, best optical crown glass, having straight edges.

Length and breadth of refracting surfaces	£	s.	d.	$	
15 mm.		19	0	4.65 *b*	*Generalize*
20 „	1	10	0	7.30 *b*	*Generical*
25 „	2	0	0	9.75 *b*	*Geneta*
30 „	2	10	0	12.20 *b*	*Genista*
35 „	3	0	0	14.60 *b*	*Genteelly*
40 „	3	10	0	17.00 *b*	*Genuinely*
45 „	4	10	0	22.00 *b*	*Geodetic*
50 „	5	10	0	26.80 *b*	*Geomancy*
55 „	7	0	0	34.09 *b*	*Geoponical*
60 „	9	10	0	46.30 *b*	*Germander*

Special Mountings for Gratings, Large Prisms, Spectroscope Slits, etc., made to Order.

1276. Heliostat, Foucault's (see illustration). Mirror 30 cm. in diameter. Price on application.

No 1276. $\frac{1}{8}$ full size.

Heliostats or Cœlostats, of any special type, *to order.*

1277. Adjustable Mirror, 100 mm. in diameter, with altitude and azimuth slow motions, useful as a hand-heliostat.

£6. 0s. 0d. $29.20 *c* *Legion*

1278. Spectroscope Cell or Absorptiometer, for changing the thickness of fluid producing absorption, with stand. ... **£3. 15s. 0d.** $18.25 *c* *Barbellate*

1279. Small Fluid Prism. This is a prism of glass having two perfectly plane surfaces inclined about 60° to each other. A cylindrical hole of 20 mm. ($\frac{13}{16}$ in.) diameter passes through the centres of these surfaces. This cylindrical chamber communicates with the top of the prism by a conical neck which may be closed by means of an accurately fitting glass stopper. Both ends of the cylindrical chamber may be closed in an air-tight manner by plane parallel glass covers. The liquid which has to be examined is filled in through the conical neck. Capacity 10 to 11 c.c.

£4. 15s. 0d. $23.15 *b* *Lethean*

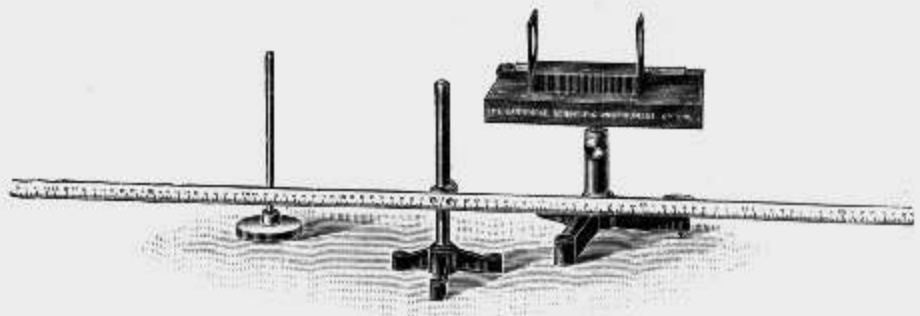
1280. Saccharimeters, Laurent's Soleil's, etc. Quotations furnished on specification of requirements.

1281. Phosphoroscope, Becquerel's, directly driven by small electric motor. The object under investigation is alternately illuminated while hidden from the observer, and presented to view while screened from illumination. Thus the only light passing from the object to the observer is due to phosphorescence, the interval of time which elapses between "insolation" and observation being made as short as 1/40,000 second when desired.

£5. 10s. 0d. **$26.80** *c* *Legume*

When ordering please state voltage of circuit from which motor is to be driven.

1282. Cardinal Points of Lens Systems, apparatus devised by Mr G. F. C. Searle, F.R.S., for exemplifying the determination of cardinal points and principal focal distances; including a system of two simple lenses, as illustrated. ... **£2. 10s. 0d.** **$12.20** *c* *Gladiole*



No. 1282. ½ full size.

1283. Focal Lines formed by Lenses, apparatus for experiments on, devised by Mr G. F. C. Searle, F.R.S. The object consists of two black lines, respectively vertical and horizontal, ruled on a small vertical screen which can be displaced horizontally in its own plane, the lens remaining fixed. The corresponding positions of the conjugate foci for the two lines being mapped, the curvature of field, astigmatism, and distortion are readily found.

£1. 1s. 0d. **$5.10** *c* *Gladwin*

1284. Parallel Glass and Prism Tester, designed by Messrs Chalmers and Ryland for testing worked glass plates, and right-angled reflecting prisms. If a plate is not parallel, or a prism not truly right-angled, two images of an illuminated slit are seen by reflection, the separation between the images indicating how considerable an error exists. (See special leaflet describing the instrument, sent free on application.) ... ... **£5. 0s. 0d.** **$24.40** *c* *Limy*

1285. Focometric Slide, for determining the principal foci of lenses, and for accurately focussing collimators, etc. A carriage provided with vees for supporting a telescope is capable of lateral displacement through 125 mm. If this telescope is sighted upon a correctly focussed artificial star or other object at infinity, the supporting carriage may be displaced bodily upon its slide without causing any apparent displacement of the image in the principal focal plane of the telescope. Thus for example if the telescope is set to view a fixed sight-mark through a fixed converging lens, it is easy to determine with accuracy when the sight-mark is in the principal focal plane of the lens. The absence of error due to curvature of the slide may be verified by reversing the collimator upon the carriage. Without telescope.

£2. 10s. 0d. **$7.30** *c* *Lemma*

With telescope of 20 mm. aperture, with cross-wires.

£4. 10s. 0d. **$21.90** *c* *Limner*

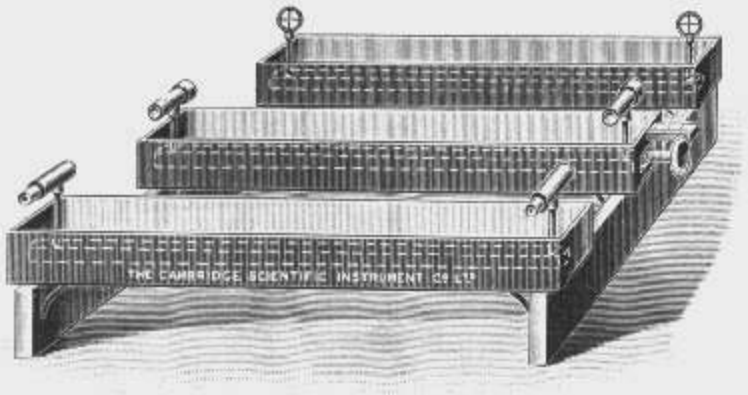
§ 8. HEAT.

1300. Expansion of a Heated Metal Bar, apparatus for showing. The expansion, highly magnified, by means of an Ayrton and Perry helical spring, is read off from the position of a pointer upon a circular scale.

Complete, with two rods, one of brass and the other of practically non-expansible nickel steel.

£1. 15s. 0d. $8.50 *c* *Friarscowl*

1301. Linear Coefficient of Expansion of Bars, apparatus for determining, by Roy and Ramsden's method (see illustration).



No. 1301. $\frac{1}{12}$ full size.

The bar is placed in a copper trough and surrounded by water. Two iron troughs in which are placed standard bars of iron surrounded by ice are arranged parallel to and on either side of the copper trough. The centre bar supports the object glasses of two telescopes, the eye-pieces being carried by one of the iron bars, and cross wires by the other iron bar. The bar under examination is mounted on rollers and the amount of its expansion is measured by means of a fine micrometer screw. See Watson's *Text-book of Physics*, p. 215.

£15. 15s. 0d. $76.70 *c* *Fricassee.*

1302. Steel Gas-regulator (see illustration) for maintaining Incubators, Baths, Sterilisers, etc. at a constant temperature. New design, entirely of steel. Adjusted with ease to maintain the required temperature. No risk of breakage. Direct metallic connection to the gas supply is readily made, thus avoiding the use of rubber tubing and consequent risk of fire. Diameter of steel tube 19 mm.

Price without mercury... ... **£2. 0s. 0d.** $9.75 *c* *Livingly*

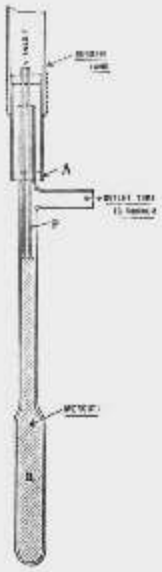
No. 1302. $\frac{1}{6}$ full size.

1303. Bi-metallic Temperature Regulator, consisting of two dissimilar metals in a tube, which on being heated or cooled make or break an electric circuit. The temperature at which this occurs can be regulated by means of a screw.

£2. 0s. 0d. $9.75 *c* *Exclude*

1304. Page's Temperature Regulator (see illustration). A very simple and effective gas regulator. It consists of a glass bulb containing mercury, the gas passing over the surface of the mercury from the inlet pipe *P* to the outlet. The position of the inlet pipe is vertically adjustable. On a rise of temperature the mercury closes the orifice of the inlet, thus cutting off the gas. A bye-pass is provided to prevent the flame from being entirely extinguished.

2s. 6d. $0.60 *b* *Bedagat*



No. 1304. $\frac{1}{4}$ full size

1305. Reichert's Temperature Regulator. A similar regulator to the above, but with the addition of a fine motion screw for adjusting the height of the mercury.

5s. 0d. $1.20 *b* *Bedaggle*

1306. Griffiths' Gas Pressure Regulator, for maintaining constant, within 0·1 mm., the head of water pressure under which gas is delivered.

£5. 0s. 0d. $24.40 *d* *Limous*

1307. Constant Temperature Apparatus. This Thermostat was designed and first constructed as an adjunct to the Spectrograph of the 24-inch Refractor of the Royal Observatory, Cape of Good Hope. In this case the special object in view was to maintain the prisms and other parts as accurately as possible at a constant temperature day and night for a considerable period. The same devices have since been employed in instruments constructed for the Mount Wilson Observatory, California, and also for Lord Berkeley. The apparatus has been found most successful in maintaining an almost absolutely constant temperature over a very large range. Electric lamps or heating coils are switched in or out of circuit by an electrical control working in connection with a platinum thermometer.

The apparatus can also be arranged to control steam coils or gas jets. *To order.*

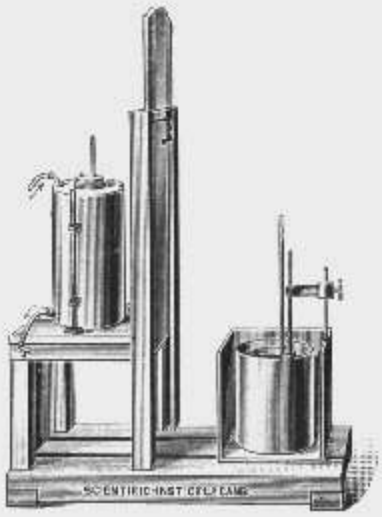
See "An Electric Thermostat," by Horace Darwin, F.R.S., *Phil. Mag.*, April, 1904.

1308. Calorimeter, for use by the Method of Mixtures. This is similar to that used at the Cavendish Laboratory, and described in Glazebrook and Shaw's *Practical Physics.* (See illustration.) ... ... **£4. 10s. 0d.** **$21.90** *d* *Frigatoon*

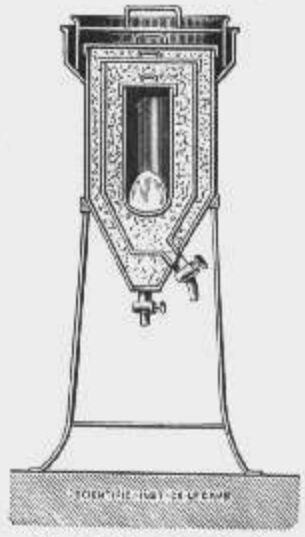
1309. Lavoisier's Ice Calorimeter (see illustration). Three copper vessels are placed one inside another, the substance whose specific heat is to be determined being placed in the innermost vessel. The two outer vessels are packed with ice. The specific heat of the substance can be calculated from the quantity of ice melted in the intermediate vessel.

£2. 2s. 0d. **$10.25** *d* *Fringetree*

1310. Calorimeter, Dulong and Petit's, for determining the specific heat of liquids by the method of cooling. A vessel containing the liquid is closed by a cork through which a thermometer is passed, and is placed inside a larger double-walled copper vessel forming a water-jacket. Complete with two thermometers. ... **£1. 15s. 0d.** **$8.50** *d* *Frippery*



No. 1308. $\frac{1}{12}$ full size.



No. 1309. $\frac{1}{6}$ full size.

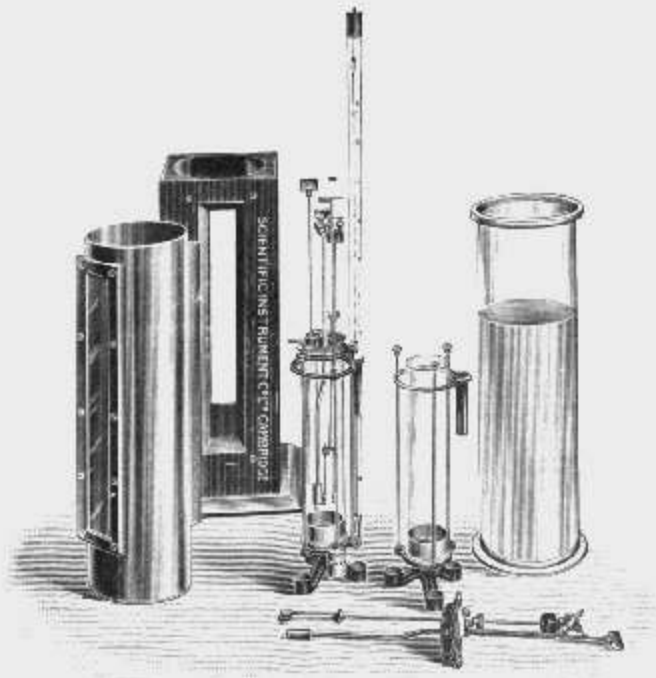
1311. Rosenhain's Fuel Calorimeter, for determining the calorific value of coal or liquid fuel (see illustration). The sample is compressed from powdered coal, or is a tared combustible pellet soaked in liquid fuel. It is burnt in a current of oxygen within a glass vessel completely immersed in water, to which latter the heat evolved is very completely imparted. The rise of temperature is read by a delicate thermometer.

	£	*s.*	*d.*	$	Codeword
Calorimeter A with ball-valve and brass vessel ...	7	10	0	36.50 *c*	*Frislet*
Calorimeter B (simple type) with glass vessel ...	5	0	0	24.40 *d*	*Fruitful*
Coal-compressing mortar		12	6	3.10 *d*	*Bestwick*
Glass measure to contain 1 litre, divided 10 c.c. ...		5	0	1.30 *c*	*Blossomed*
Thermometer divided to 0°·05 C. and reading from 10° to 25°	1	0	0	4.90 *c*	*Adventurine*
Thermometer 0°—50° C. divided to 0°·1 C. ...		5	0	1.30 *c*	*Bombazine*
4 yards stout indiarubber tubing		8	0	2.00 *c*	*Bonassus*

	£	s.	d.	$	
4 porcelain crucible lids		1	0	0.24 *c*	*Bondsmen*
½ litre wash-bottle		1	6	0.36 *c*	*Boneash*
Calorimeter, A, with simple thermometer, complete with accessories	10	3	0	49.50 *c*	*Boscage*
Calorimeter, B, with simple thermometer, complete with accessories	7	13	0	37.30 *d*	*Begardus*
Tube of standardized Coal Briquettes		7	6	1.90	*Headstall*
Tube of standardized Absorption Pellets		3	0	0.80	*Hearken*

List No. 31, fully describing the details of this Calorimeter will be sent on application.

For full particulars, see special leaflet; also *Steam and Steam Engines*, 14th Edition, p. 48, by Prof. Jamieson.



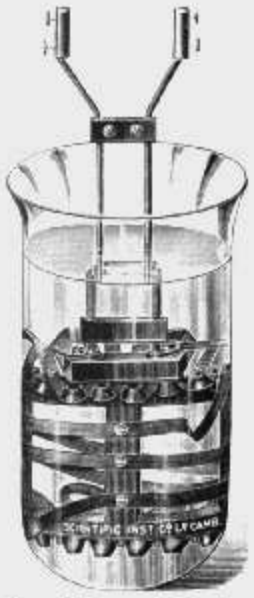
No. 1311. $\frac{1}{10}$ full size.

1312. Heat Equivalent of Electric Energy, Apparatus for Measuring. A resistance formed of a broad strip of manganin is immersed in water. An electric current is to be applied to heat the manganin strip, and from the rise in temperature of the water the heat equivalent of the electric energy expended can be determined. The coil, thermometer, etc., are contained in a thin copper calorimeter; not in a glass vessel as illustrated.

Complete with mercury thermometer.

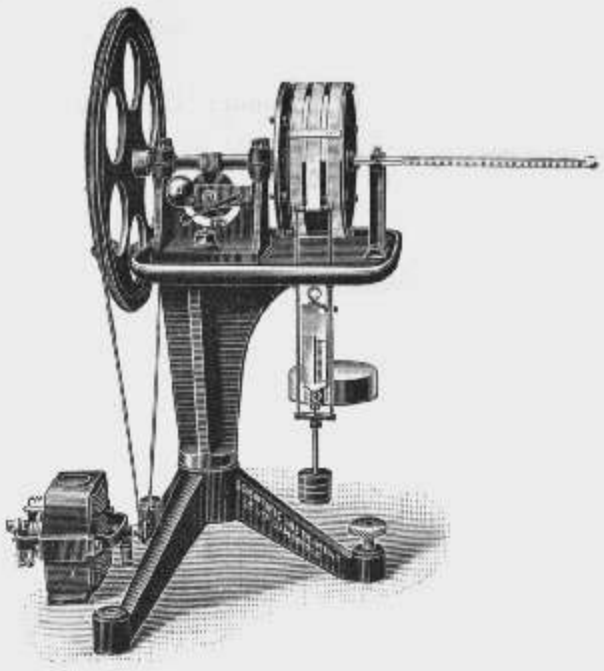
£2. 15s. 0d. $13.40 *d* *Frockcoat*

(See Ayrton's *Practical Electricity*, 1900 Edition, p. 320.)



No. 1312. $\frac{1}{4}$ full size.

1313. Mechanical Equivalent of Heat, Callendar's Apparatus for Determining (see illustration). This apparatus, invented and patented by Professor H. L. Callendar, F.R.S., comprises a cylindrical calorimeter of thin brass, whose axis is horizontal, containing a known quantity of water. This is rotated at a moderate speed either by hand or by means of a water or electric motor. Unequal weights are suspended from the ends of a silk belt slung over the cylinder, and so arranged as to make one and a half complete turns round the cylinder. Stability of equilibrium is secured by the addition of a light spring balance which acts in direct opposition to the lighter weight. Since this spring balance contributes only a small (positive) term to the effective difference of load at the two ends of the belt, small errors in its readings are relatively unimportant. The weights are adjusted by trial to suit approximately the friction of the belt, the final adjustment being effected automatically by the spring balance. A counter registers the number of turns which have been given to the calorimeter, while the rise of temperature is read by means of a bent mercury or platinum thermometer, inserted through a central opening in the front end of the cylinder.



No. 1313. ⅛ full size.

The chief advantages of this apparatus are:—

1. The friction is very nearly independent of the speed.
2. The balance is automatic.
3. There is no change in thermal capacity of the calorimeter with change of speed or of load.
4. There is no pulley- or bearing-friction to introduce errors.
5. There are no forced vibrations and no dash pot is required.
6. The factors of the mechanical work expended are ascertainable to a high degree of accuracy.

A lecturer can obtain a value of "J" correct to ½ per cent. in about 10 minutes, in the presence of a class of students.

Price including glass thermometer but without motor.

£12. 10s. 0d. **$60.90** *d* *Balsamic*

For full particulars, see special leaflet.

Callendar and Griffiths' Platinum Resistance Thermometers. A coil of fine platinum wire wound on a mica frame is protected by a glass or porcelain tube. The increase of the resistance of this platinum coil with rise of temperature indicates the amount of that rise. By making the coil form one arm of a Wheatstone Bridge, any change in resistance, and consequently of temperature, can be measured with great accuracy.

An arrangement of compensating leads eliminates all errors due to variation of the temperature of the wires connecting the thermometer with the indicator or recorder. The thermometer can thus be placed in positions where it would be impossible to read or use a mercury thermometer; while a series of thermometers distributed over a considerable area can be read from one central station by means of an indicator and switchboard. Temperatures as low as −200° C. and as high as 1200° C. can be measured without difficulty.

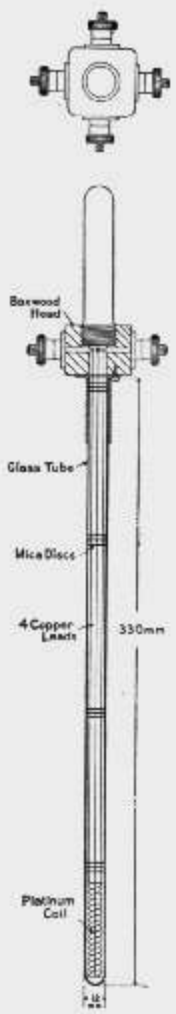
When used in conjunction with Callendar's Patent Electric Recorder these thermometers furnish continuous records of temperature.

For further information regarding the prices of Callendar Recorders, resistance thermometers especially suitable for laboratory, educational and industrial work, temperature indicators and accessories, see special catalogue, "Technical Thermometry," List No. 39, which will be sent post free on application. The figures in brackets refer to this list.

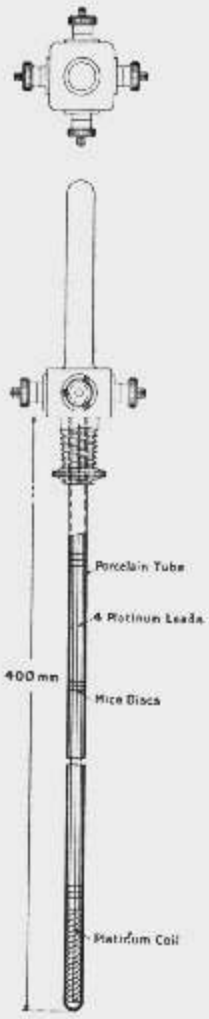
Electrical Thermometers especially suitable for use in Laboratories.

Note. The fundamental interval (F.I.) is the increase of resistance due to a rise of temperature from 0° to 100° Centigrade. Where a resistance thermometer is supplied for use with a bridge, a certificate of the data is furnished.

1314. [630 *t*] Platinum bulb, in glass protecting tube 33 cm. long and 12 mm. in diameter, with copper leads, resistance in ice approximately 2·8 ohms, F.I. one ohm, suitable for temperatures up to 300° C. (see illustration). ... ... **£2. 0s. 0d.** $9.80 *c* *Imbarn*



No. 1314. [630 *t*] ½ full size.



No. 1316. [633 *t*] ½ full size.

1315. [632 *t*] Platinum bulb, in porcelain tube 33 cm. long and 14 mm. in diameter, with platinum leads, resistance in ice approximately 2·8 ohms, F.I. one ohm, for measuring temperatures up to 1200° C. ... ... **£4. 10s. 0d.** $22.00 *d* *Lampass*

1316. [633 *t*] Platinum bulb, in porcelain tube 40 cm. long and 12 mm. in diameter, with platinum leads, resistance in ice approximately 2·8 ohms, F.I. one ohm, with simple device for holding the porcelain tube in order that the tube may be readily replaced (see illustration).
£5. 0s. 0d. $24.40 *d* *Imbibe*

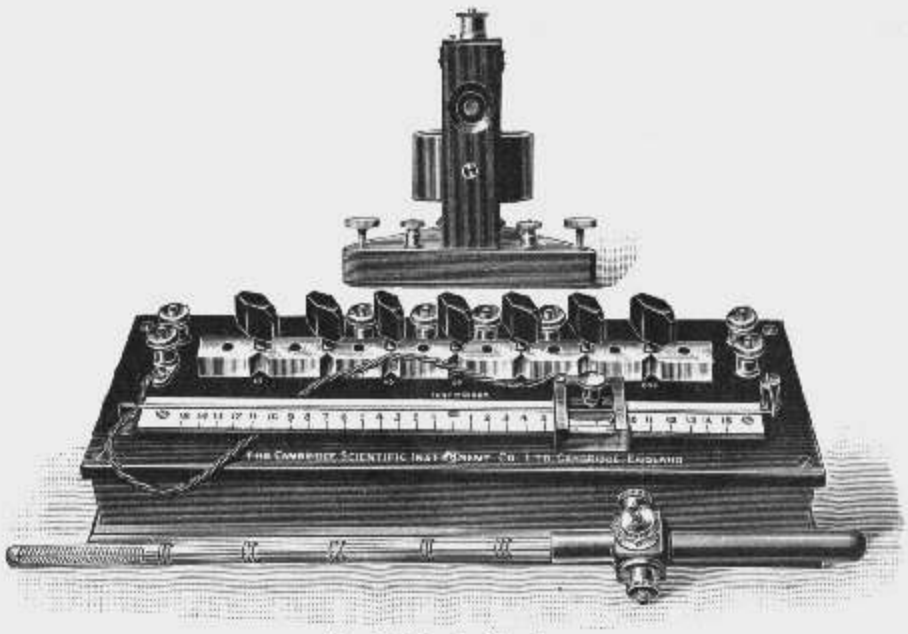
This pattern has been employed by Messrs Heycock and Neville in their investigations on the melting points of metals and alloys.

For the accurate measurement of temperature by means of platinum thermometers, special resistance bridges should be employed. These bridges are described in detail in the catalogue "Technical Thermometry" previously mentioned. As a guide to the type of equipment necessary for resistance thermometry, two complete outfits are detailed below.

1317. [672 *t*] **Outfit for teaching Resistance Thermometry** (see illustration):—

	£	*s.*	*d.*	$	
Callendar and Griffiths' Bridge, Type I.	5	0	0	24.40	
Galvanometer, Ayrton-Mather type	3	15	0	18.30	
Resistance Thermometer, glass tube, No. 1314 ...	2	0	0	9.80	
6 feet of four-way flexible leads with tangs ...		8	0	2.00	
	11	3	0	54.50 *c*	*Impeach*

(Galvanometer-lamp and scale, dry cells, etc. will also be required.)



No. 1317. ⅓ full size.

1318. [674 *t*] **Outfit for Research with Resistance Thermometers**:—

	£	*s.*	*d.*	$	
Callendar and Griffiths' Bridge, Type III., with Collins' Patent Mercury contacts	36	10	0	177.80	
Broca Galvanometer, 10 ohm coils	7	10	0	36.50	
Galvanometer lamp and scale	2	0	0	9.80	
Resistance Thermometer, Heycock and Neville type, porcelain tube, platinum leads, No. 1316 ...	5	0	0	24.40	
Griffiths' Thermo-Electric Key	2	2	0	10.20	
3 yds. of four-way flexible leads with tangs ...		9	6	2.30	
2 Dry Cells		4	0	1.00	
	53	15	6	262.00 *d*	*Impinge*

1319. [103 *t*] **Whipple's Patent Gas Scale Temperature Indicator, Direct Reading,** for use with Callendar and Griffiths' Resistance Thermometers.

This instrument has been designed to avoid the trouble and risk of error involved in converting temperatures obtained with a platinum thermometer to the scale of the gas thermometer. With this instrument no table of corrections is required, the temperatures being given directly on the gas scale. Temperatures which are changing rapidly can be closely followed.

The instrument is extremely portable and is fitted in case with batteries complete (see illustration). Reading from − 10° to 1200° C. graduated to degrees.

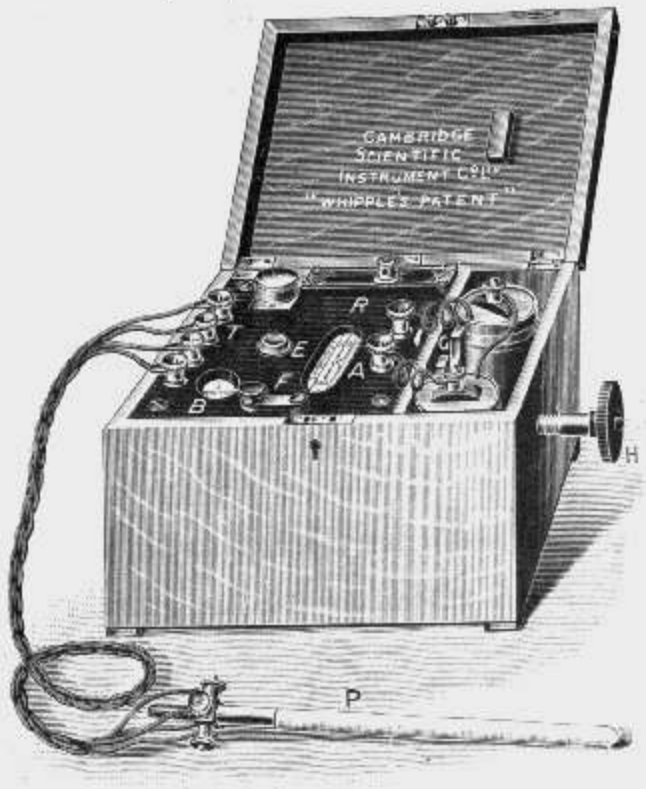
£20. 0s. 0d. **$97.40** *d* *Foundry*

Thermo-Electric Couple, in small porcelain tube 33 cm. long, with head and terminals, the wires being insulated by small porcelain jackets.

1320. [550 *t*] Platinum, platinum-iridium. ... **£2. 10s. 0d.** **$12.20** *d* *Hurricane*

1321. [555 *t*] Platinum, platinum-rhodium. ... **£2. 14s. 6d.** $13.30 *d* *Hussar*

Couple similar to the above but fitted with handle containing 100 cms. of wire wound on reels to replace the thermo-junction if damaged (see illustration).



No. 1319. ½ full size.

1322. [647 *t*] Platinum, platinum-iridium. ... **£4. 5s. 0d.** $20.70 *c* *Imbrown*

No. 1322. ½ full size.

No. 1324. ⅛ full size.

1323. [648 *f*] Platinum, platinum-rhodium. ... **£4. 12s. 6d.** **$22.50** *c* *Imbrute*

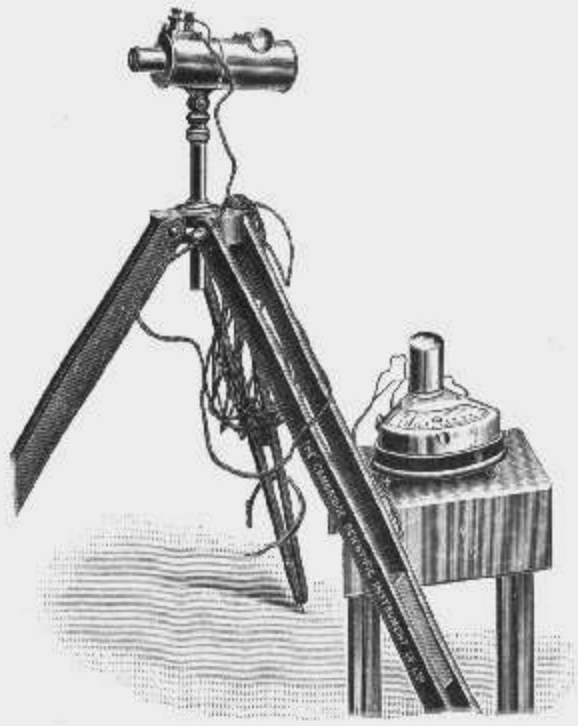
Millivoltmeter for use with the above platinum thermo-couples. The instrument is practically independent of levelling, and is enclosed in a teak case provided with a handle. One scale is divided into half millivolts, and the Centigrade temperature scale is graduated into 20 degree divisions from 0 to 1600° C.

1324. [500 *f*] For use with platinum, platinum-iridium couple.
£9. 0s. 0d. **$43.90** *d* *Horal*

1325. [501 *f*] For use with platinum, platinum-rhodium couple.
£9. 0s. 0d. **$43.90** *d* *Horned*

For Patent Non-Photographic Recording Millivoltmeter, see full description in "Technical Thermometry," List No. 39.

Féry's Patent Radiation Pyrometer, for temperatures from 700° C. up to *any higher limit* (see illustration). No part of the instrument is heated above 100° C. so that **the life of the thermometer is practically unlimited.** Complete outfits for the direct observation of temperature, from **£27. 3s. 0d.** ($132.50); for continuous recording from **£40. 18s. 6d.** ($199.40). For further particulars of prices, construction, etc. see List No. 39.



The Féry Radiation Pyrometer. $\frac{1}{10}$ full size.

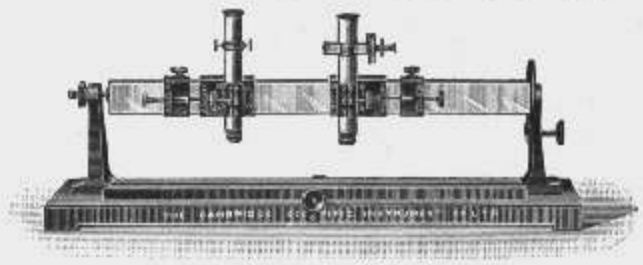
Jena Glass Thermometers, reading from 0 to 100° C.

1326. Divided on the stem in degrees. ... each **3s. 0d.** **$0.75** *Chromium*

1327. Divided in half degrees. ... ... each **4s. 6d.** **$1.10** *Chronicled*

1328. Calibration of bore of Mercury Thermometers. (See illustration.) Two microscopes, suitably mounted, can be moved along a horizontal scale. The length of a thread of mercury in the thermometer stem may be read over the whole length of the stem, changes made in the distance between the two microscopes being read micrometrically. (See Guillaume's *Thermométrie de Précision.*)

As illustrated. ... ... **£15. 0s. 0d.** **$73.00** *b* *Frondose*



No. 1328. $\frac{1}{10}$ full size.

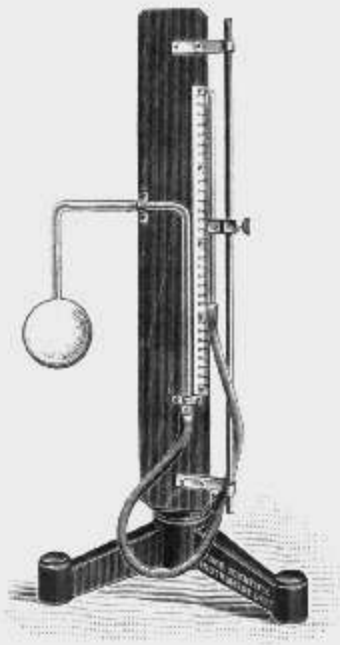
1329. Thermo-Pile, of 36 couples, mounted on pillar and base. The pile cell can be raised or lowered. With cone, in case. ... ... **£3. 0s. 0d.** $14.60 *b* *Frontless*

1330. Boyle's Law Apparatus. Large pattern, with glass vessel and accessories enabling the apparatus to be used as an air-thermometer. Scale 2 metres long. See illustration.
£11. 0s. 0d. $53.60 *d* *Frostmist*

1331. Constant Volume Air Thermometer, simple form (see illustration).
£2. 5s. 0d. $11.00 *d* *Fruitful*

1332. Joly's Gas Thermometer, with scale of mirror glass. In this constant-volume instrument a side-tube and glass stop-cock are provided, so that the air in the bulb may be replaced by other gas (see illustration). ... ... **£8. 0s. 0d.** $39.00 *d* *Latraat*

No. 1330. $\frac{1}{2\frac{1}{8}}$ full size.



No. 1331. $\frac{1}{6}$ full size.

No. 1332. $\frac{1}{1\frac{1}{4}}$ full size.

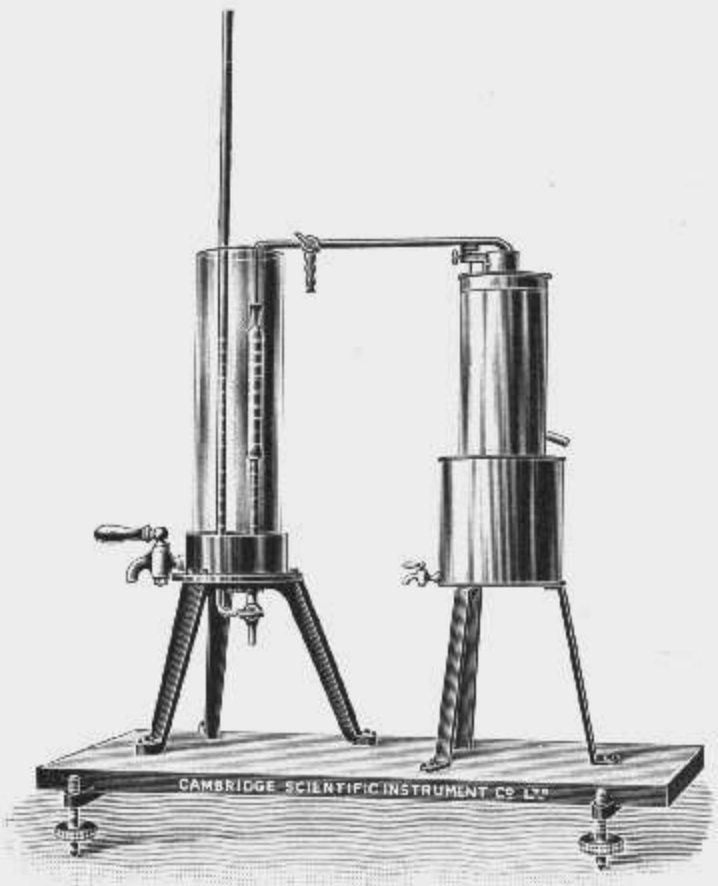
1333. Expansion of Gases at Constant Pressure. The gas is contained in a bulb connected to a mercury manometer, with graduated tube fitted with stop-cocks and surrounded by a jacket, being fixed on a stand with levelling screws. The apparatus can be supplied with or without a hypsometer for heating the gas. (The instrument as now made is somewhat different from that shown in the illustration.)

With hypsometer complete. ... ... **£8. 5s. 0d.** $40.20 *d* *Latria*
Without hypsometer. ... ... **£6. 15s. 0d.** $32.90 *d* *Lodgement*

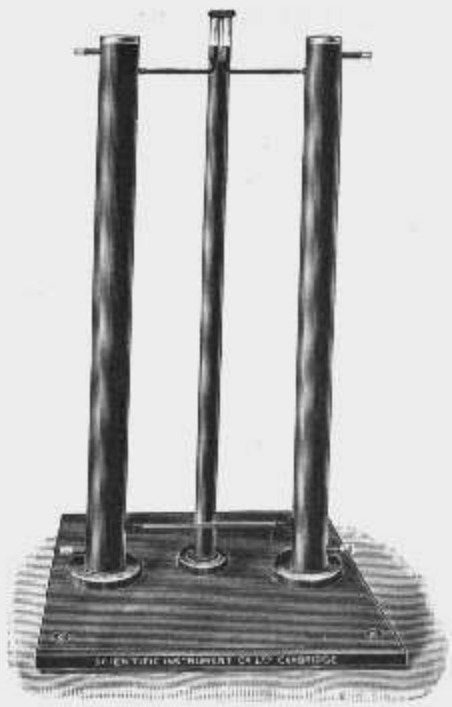
1334. Coefficient of Expansion of Mercury, apparatus for determining. This is a modified form of Dulong and Petit's apparatus. Two long vertical glass tubes are connected together by a cross tube, and are surrounded by iron cylinders which can be filled with ice or steam. The whole is mounted on a substantial base board. Special arrangements are adopted for making the measurements of the heights of the mercury columns convenient and accurate. (See illustration.)

Price without mercury. ... ... **£8. 10s. 0d.** $41.40 *c* *Latrociny*

1335. Hypsometer. Of the well-known Regnault form, 45 cm. high, made in copper for standardising the thermometer in steam at atmospheric pressures (100° C. at 760 mm. pressure).
(See illustration.) Price without gas ring. ... **£1. 15s. 0d.** **$8.50** *d* *Impale*
Gas ring for above. ... ... **5s. 0d.** **$1.20** *d* *Laggard*

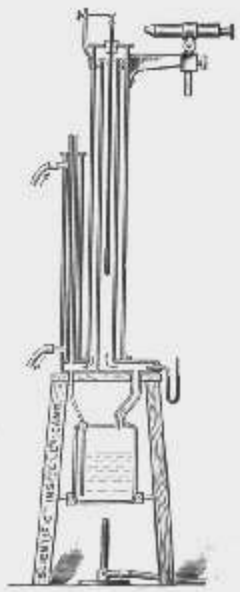


No. 1333. ⅓ full size.



No. 1334. $\frac{1}{2^{1}\!/_{2}}$ full size.

No. 1335. $\frac{1}{1^{1}\!/_{3}}$ full size.



No. 1337. $\frac{1}{2^{1}\!/_{8}}$ full size.

No. 1338. $\frac{1}{1^{1}\!/_{3}}$ full size.

No. 1339. $\frac{1}{1^{1}\!/_{9}}$ full size.

1336. Hypsometer, Regnault's, with self-filling attachment. The body of the hypsometer communicates with a small vessel into which water may be allowed to trickle slowly, to make good the loss by evaporation, the excess escaping by an overflow pipe. The hypsometer requires no attention, and can be used without interruption for any length of time.
£3. 15s. 0d. **$18.30** *d* *Inditch*

1337. Hypsometer. Special form designed by Dr Guillaume for ascertaining the boiling point with great accuracy. The thermometer may be placed in both vertical and horizontal positions. (See *Thermométrie de Précision*, by Guillaume, and Watson's *Physics*, p. 209.) Complete with reading microscope, manometer and condenser, as illustrated.

£25. 0s. 0d. $121.75 *a* *Fumarole*

1338. Ice Vessel. A copper vessel, 35 cm. high, with double walls for heat insulation. The thermometer is placed in ice in the inner vessel for determining the freezing point. A drain cock is provided. (See illustration.)

Price without stand. ... ... £1. 0s. 0d. $4.90 *d* *Etiology*
Tripod stand. ... ... 5s. 0d. $1.20 *d* *Immure*

1339. Saturation Pressure of Vapours, a modified form of Regnault's Apparatus for determining. The whole apparatus is immersed in water, contained in a brass box fitted with plate glass windows. As now made the instrument is slightly different from that shown in the illustration.

£6. 5s. 0d. $30.50 *c* *Fumblingly*

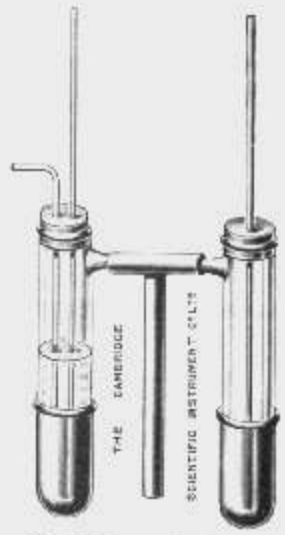
1340. Vapour Densities, apparatus for determining, by Dumas' method. Outer metal vessel, bulb tube, thermometer, stirrer, and supports (see illustration).

£1. 10s. 0d. $7.30 *b* *Fumigation*

1341. Vapour Densities, by Victor Meyer's method. Glass bulb tube with branch and stopper, and an outer glass vessel for heating. ... 8s. 0d. $1.95 *b* *Fumy*

No. 1340. ⅓ full size.

No. 1342. ¼ full size.



No. 1344. ½ full size.

1342. Wet and Dry Bulb Hygrometer. (The illustration is not correct in detail.) Mason's standard form, consisting of two mercury thermometers on a stand, and divided on the stem, the bulb of one being kept moist by means of a cotton wick, one end of which dips into a vessel of water. ... ... £1. 15s. 0d. $8.50 *d* *Fundle*

Wet and Dry Bulb Hygrometers are also made with platinum thermometers connected to a Callendar Recorder. This arrangement is in use at the Khedival Observatory at Cairo.

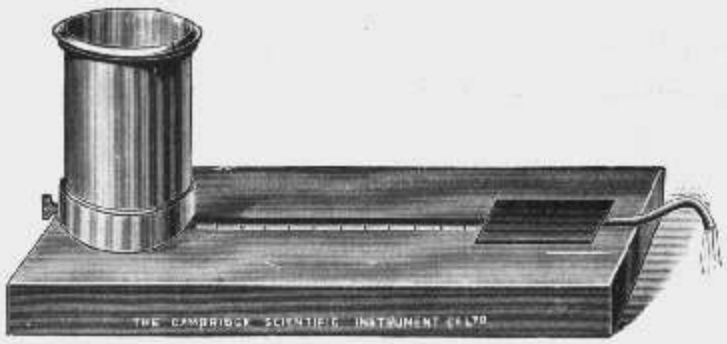
For prices see special List, No. 39.

1343. Daniell's Hygrometer. ... ... £1. 10s. 0d. $7.30 *d* *Fungiform*

1344. Regnault's Hygrometer. Two glass tubes fitted with silver caps, as shown in the illustration, with two mercury thermometers divided to tenths of a degree, mounted on stand

without Aspirator. ... ... £3. 10s. 0d. $17.00 *c* *Latency*
Ditto, with Aspirator. ... ... £4. 10s. 0d. $22.00 *c* *Latish*

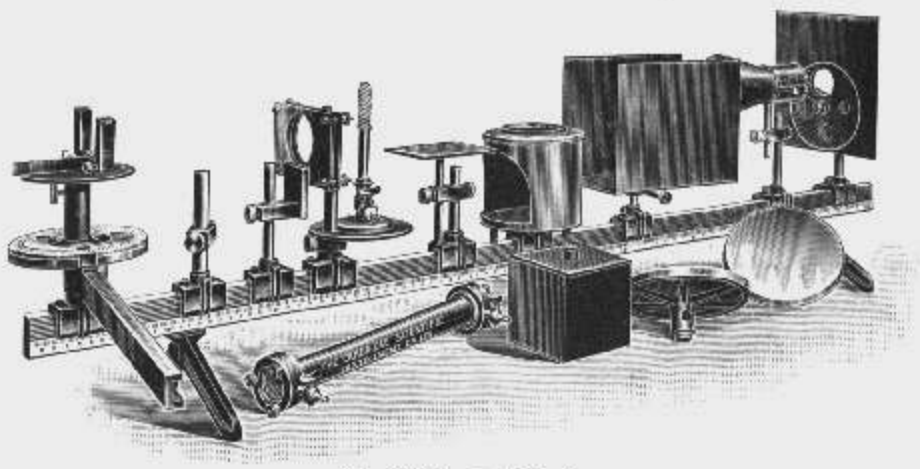
1345. Dines' Hygrometer. (See illustration.) **£1. 15s. 0d.** **$8.50** *d* *Fungous*



No. 1345. ½ full size.

1346. Melloni's Apparatus for studying the reflection, refraction, absorption, etc. of radiant energy. The bed is a substantial steel bar, and the scale is of brass, accurately divided in millimetres. The apparatus includes all the accessories named below, with suitable pillars, clamps, etc. for their support and adjustment, as illustrated. One of the pillars fixed to the bed has a radial arm which is fitted with divided circle, and in turn carries three pillars.

Complete. ... ... **£27. 10s. 0d.** **134.00** *c* *Funicle*



No. 1346. $\frac{1}{12}$ full size.

Accessories included in the above, any of these may be omitted from No. 1346 and the price correspondingly reduced.

1347. Thermopile ... ... **£3. 0s. 0d.** **$14.60** *b* *Loftily*

1348. Glass cell (for liquids). ... ... **8s. 6d.** **$2.10** *c* *Funnelnet*

1349. Double screen, with variable aperture, and shutter for closing the same. ... ... **£2. 10s. 0d.** **$12.20** *c* *Lettis*

1350. Leslie's cube (copper) with four different radiating surfaces. ... ... **2s. 6d.** **$0.60** *c* *Leveret*

1351. Table for spirit lamp. ... ... **7s. 6d.** **$1.85** *c* *Fuscation*

1352. Platinum gauze mantle on Bunsen burner. ... ... **£2. 2s. 0d.** **$10.25** *c* *Furzechat*

1353. Fish-tail gas-burner and clip. ... **3s. 0d.** **$0.75** *c* *Fustianist*

1354. Rocksalt prism, 35 mm. sides and 45 mm. high. ... ... **£1. 5s. 0d.** **$6.10** *c* *Futurist*

1355. Rocksalt lens, 40 mm. diameter. ... **£1. 0s. 0d.** **$4.90** *c* *Fuzzy*

1356. Two plates of rocksalt. ... ... **£1. 5s. 0d.** **$6.10** *c* *Choleric*

1357. Brass tube with rocksalt plates at the ends, and provided with stop-cocks. ... ... **£2. 15s. 0d.** **$13.40** *c* *Chording*

1358. Two concave mirrors. ... ... **£2. 2s. 0d.** **$10.25** *c* *Christen*

1359. Boys' Radio-Micrometer. A single closed circuit of small dimensions and very small moment of inertia is made up of dissimilar metals and suspended by a delicate quartz-fibre between the poles of a permanent magnet. The radiation is received at one junction, and the ensuing rise of temperature sets up a thermo-E.M.F., so that a feeble current flows round the circuit, which is accordingly deflected in the magnetic field; the only opposing influence being due to torsion of the quartz fibre. A mirror attached to the suspended system serves to measure the deflection. The instrument is dead-beat and extraordinarily sensitive. It is unaffected by stray magnetic fields and by changes of temperature, except those within its very narrow cone of vision. The suspended system can be clamped when not in use.

Price with one suspension. ... ... **£15. 0s. 0d.** **$73.00** *c* *Laudable*

1360. Freezing point of solutions, Beckmann's apparatus for determining. A glass tube containing a delicate thermometer and a stirrer is placed inside a wider tube which serves as an air jacket. The whole is enclosed in a larger outer vessel in which a freezing mixture can be placed. See Glazebrook and Shaw's *Practical Physics.* **£2. 5s. 0d.** **$11.00** *b* *Cicatrized*

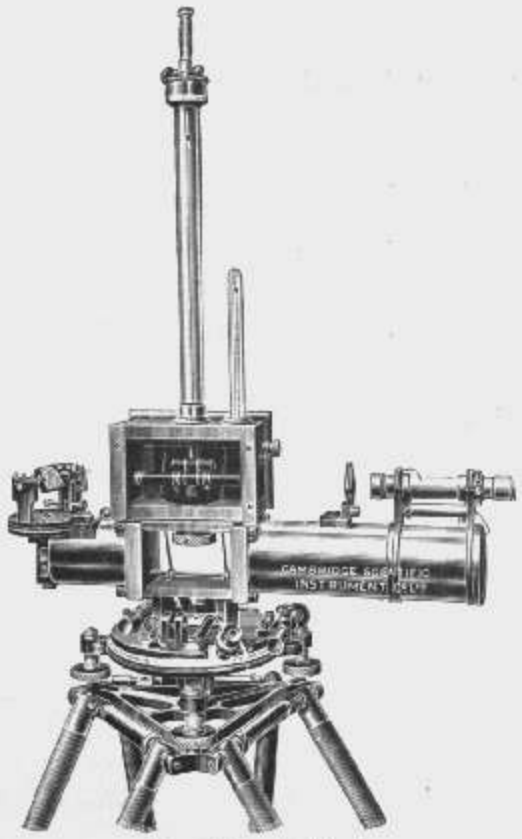
Platinum stirrer. ... ... *about* **15s. 0d.** **$3.70** *Autograph*

§ 9. MAGNETISM.

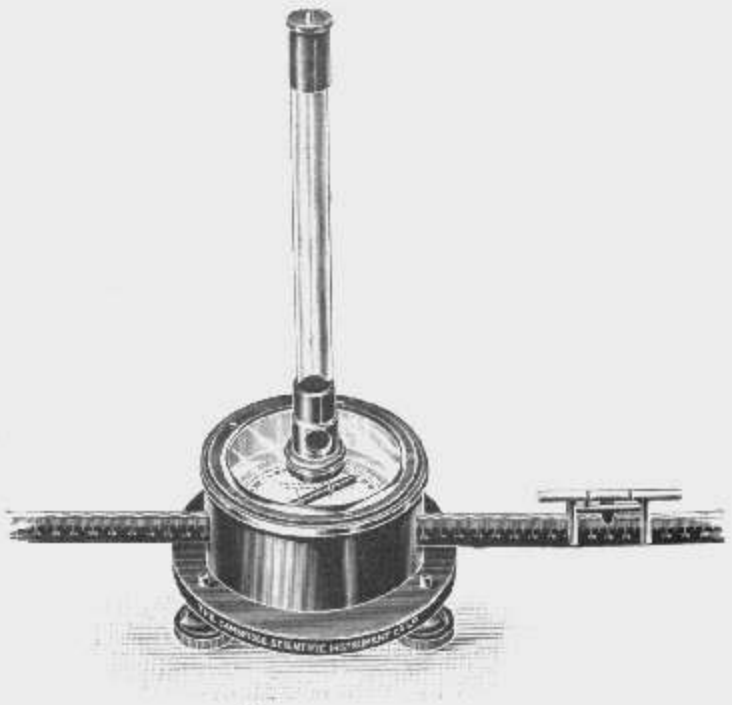
1380. Magnetometer (see illustration). Unifilar, Kew pattern, for observations of declination and horizontal force. The instrument is provided with collimator magnet, deflection magnet with mirror, inertia bar, thermometers, vibration box, deflection bar, plummet, etc. The magnets are of the dimensions approved by the National Physical Laboratory. The telescope is fitted with ivory scale as suggested by Sir A. W. Rücker. Packed in mahogany travelling case with the exception of the deflection bar and tripod which are packed in a separate case.

Price without National Physical Laboratory Certificate.

£64. 0s. 0d. **$311.70** *a* *Lemures*



No. 1380. ¼ full size.



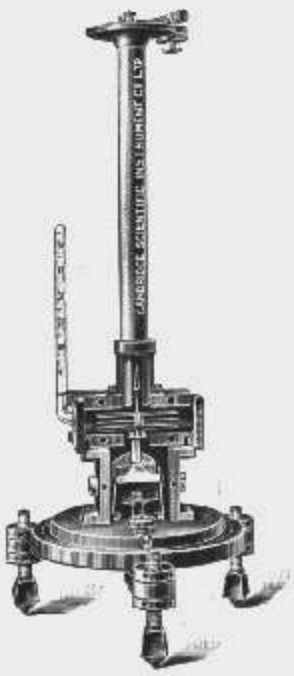
No. 1381. ⅛ full size.

1380 a. With National Physical Laboratory Certificate.
£70. 0s. 0d. **$340.90** *a* *Comeliarch*

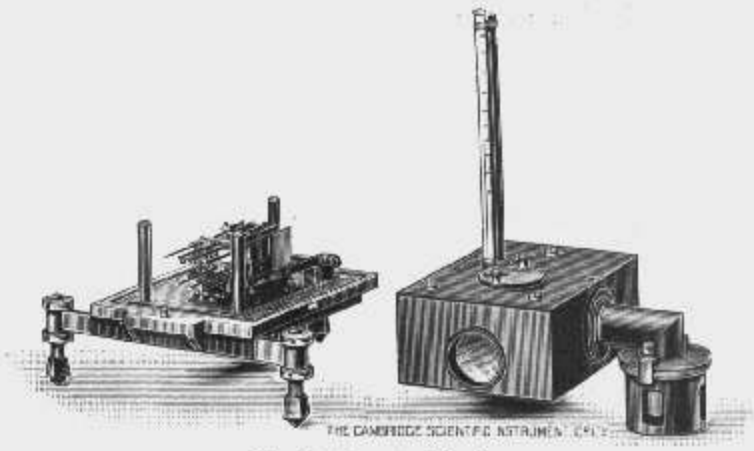
1381. Students' Magnetometer. A circular brass box is supported on three levelling screws. A boxwood scale about 80 cms. long and divided in millimetres transfixes the box. A carrier for a deflecting magnet is provided, with pointer for reading its position. The entire cover, with suspension tube, is readily removable. The deflectable magnet is hung in a brass stirrup, a pointer being fixed below, just over the scale. The suspension is readily renewed. A mirror is provided, for observation with a telescope and scale if desired. (See illustration.)
£4. 10s. 0d. **$21.90** *d* *Cinereous*

Magnetographs, as designed by Professor W. Watson, F.R.S. The Declination and Horizontal Force instruments are practically similar except that the suspension in the Declination instrument is a silk fibre or a strip of phosphor-bronze, and that in the Horizontal Force instrument it is a quartz fibre. Illustration No. 1382 *b* represents the Horizontal Force instrument, as seen from behind when the back part of the metal case is removed. In the Horizontal Force instrument the magnet system consists of three, in the Declination of nine, small magnets 50 mm. long, cemented in an aluminium centre-piece. This centre-piece hooks on to the suspension and carries a mirror slung on a small cross-bar fixed just below the magnets. Immediately below this mirror is the fixed mirror, which, as well as the suspended mirror, can be adjusted about the vertical and the horizontal axes. Both mirrors are plane and immediately in front of them is placed a plano-convex lens of 165 cms. focal length. The total weight of the magnets and mirror is about 6·5 grammes. The magnet swings inside a massive block of copper, which acts as a damper and also helps to secure uniformity in the temperature of the magnet. In the case of the Horizontal Force instrument the bulb of a thermometer projects into a cavity in which the magnet swings.

The advantage of using a number of parallel magnets in the place of a single thick one is that, for a given magnetic moment, the weight is less, as is also the temperature coefficient.



No. 1382 *b*. ½ full size.



No. 1383 *b*. ⅛ full size.

The recording parts of the instrument are shown in illustration No. 1382. The drums are fitted in metal boxes which can be easily lifted out so that the drums may be taken away to a dark room for the removal of the sensitive paper. The drums are connected to the instrument by means of metal tubes. These tubes carry the slits and cylindrical lens, with an arrangement for taking eye observations. The clock is fitted with an arrangement for running the drum at two speeds, viz. one revolution in 24 hours, equal to 15 mm. of paper per hour, and one revolution in 2 hours, equal to 180 mm. of paper per hour.

The Vertical Force magnet consists of eight steel bars 10 cms. long and 2 mm. in diameter (see illustration 1383 *b*). The knife-edge and the mirror are attached to the centre of a frame which carries the magnets. This frame also carries light flags and a gravity-bob, which are used in adjusting the balance and sensitiveness of the magnet. A brass-zinc temperature compensating bar is also fitted, rendering the readings independent of changes in temperature.

The instruments are so arranged that two days' record can be taken on the one sheet of paper.

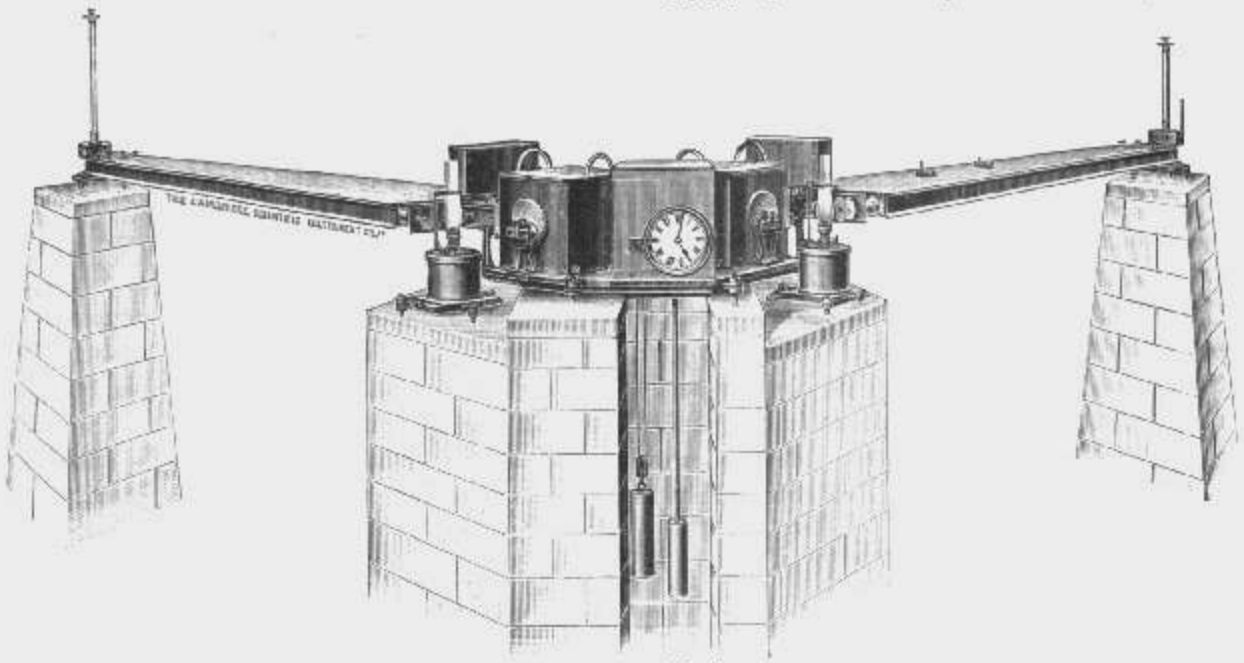
We have constructed several instruments of this type for use in the Indian Magnetic Survey.

1382. Combined Declination and Horizontal Force Magnetographs, with driving clock giving two speeds.

Complete, as shown in illustration. ... **£165. 0s. 0d.** $803.50 *b* *Cinque*

Verification at the National Physical Laboratory and expenses erecting at Kew.

£25. 0s. 0d. $121.75 *Loftiness*



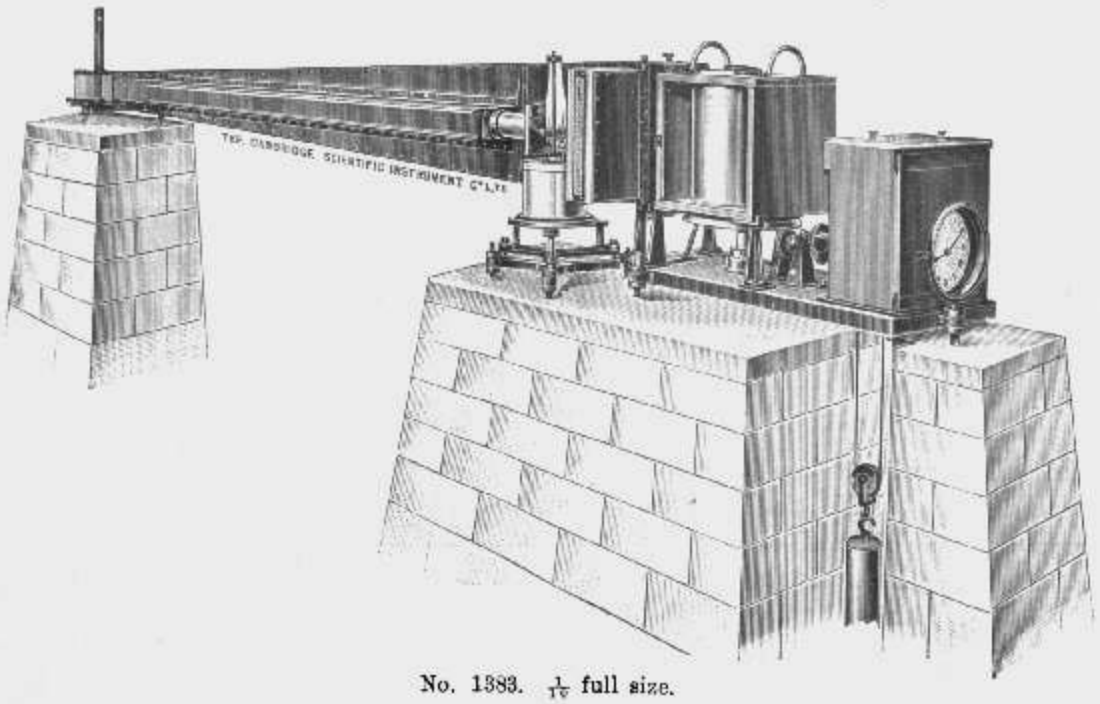
No. 1382. $\frac{1}{5}$ full size.

1383. Vertical Force Magnetograph, with driving clock giving two speeds.

Complete, as shown in illustration. ... **£110. 0s. 0d.** $535.70 *b* *Avidiously*

Verification at the National Physical Laboratory and expenses erecting at Kew.

£20. 0s. 0d. $97.40 *Levitical*



No. 1383. $\frac{1}{10}$ full size.

1384. Dip Inductor. A coil of copper wire, provided with a soft iron core can be rotated about an axis in its plane of symmetry. The ends of the coil are respectively joined to the segments of a two-part commutator, upon which rest two pairs of brushes. The coil can conveniently be rotated, and in general a resulting E.M.F. will be found at either pair of brushes. The E.M.F. arising from such rotation only vanishes at both pairs of brushes when the axis of rotation is parallel to the magnetic field in which the instrument is situated. A ring in which the spindle of the coil is journalled has quick and slow motions in azimuth and in altitude, so that the necessary adjustments are readily made; the settings where zero E.M.F. is obtained being indicated by a sensitive galvanometer connected by means of a suitable commutator to either pair of brushes as desired. The azimuth circle reads to 1 minute; the inclination circle to 20 seconds. From the four independent readings of dip obtainable, such small errors as may arise from asymmetry are readily eliminated.

	£	s.	d.	$	
Price of the instrument with hand turning-gear. ...	45	0	0	219.15 *c*	*Lineage*
Commutator for connecting either pair of brushes at will to the galvanometer.	1	10	0	7.30 *c*	*Lingerer*
Tripod for supporting the inductor for field observation.	2	2	0	10.25 *c*	*Linstock*
Broca Galvanometer (659 *t*) with one pair of coils, resistance about 100 ohms.	7	10	0	36.50 *d*	*Linguist*
Tripod with telescope and scale, for supporting and reading the galvanometer.	5	15	0	28.00 *c*	*Lionly*

1385. Dip Circle. Kew pattern, on brass tripod with levelling screws. Slow motion in azimuth with vernier reading to one minute. The needle is enclosed in a glass air-tight case, and when in use rests with its pivots on agate knife edges.

Its inclination is observed by means of two microscopes, whose positions are read to 30″ by verniers on a vertical circle.

Two bar magnets and apparatus to hold the needle for magnetising are supplied. The whole is packed in a mahogany case.

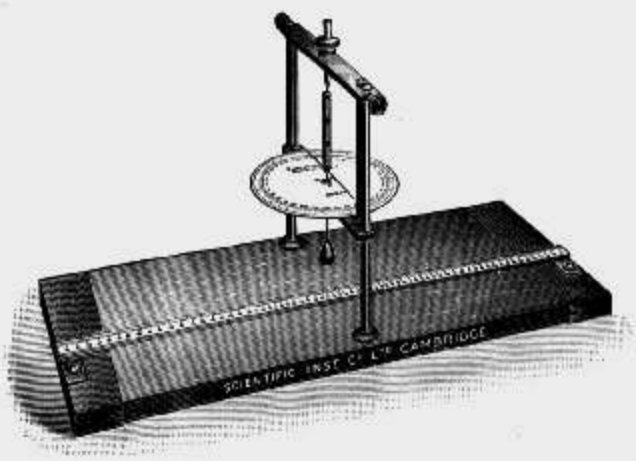
Without National Physical Laboratory Certificate.	£31.	0s.	0d.	$151.00 *a*	*Citrontree*
With National Physical Laboratory Certificate.	£32.	10s.	0d.	$158.30 *a*	*Leader*

If provided with coil for reversing the magnetism by means of an electric current.

Extra	£1.	15s.	0d.	$8.50 *a*	*Clanging*

1386. Students' Dip Circle. In circular brass case with glass front and back, mounted on a circular base provided with levelling screws, and with a slow motion in azimuth. The needle is 10 cms. long and delicately pivoted in agate centres. Silvered circles divided in degrees. (See illustration.) ... ... £8. 10s. 0d. $41.40 *d* *Claptrap*

No. 1386. ½ full size.



No. 1389. ¼ full size.

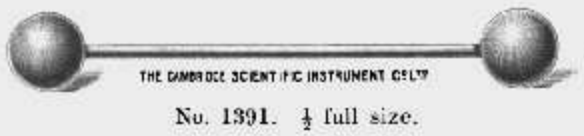
1387. Students' Dip Circle, similar to the above, but with the pivots of the needle resting on agate planes, with arrestment for needle and provision for reversing the magnetisation.
£9. 10s. 0d. $46.30 *c* *Lexify*

1388. Distribution of Magnetism in a Steel Bar, apparatus for measuring. Rowland's method, with long soft iron bar, magnetising bobbin, induction coil, and supports. See Stewart and Gee's *Practical Physics*, Vol. II. p. 388. ... **£3. 5s. 0d.** $15.80 *c* *Forestall*

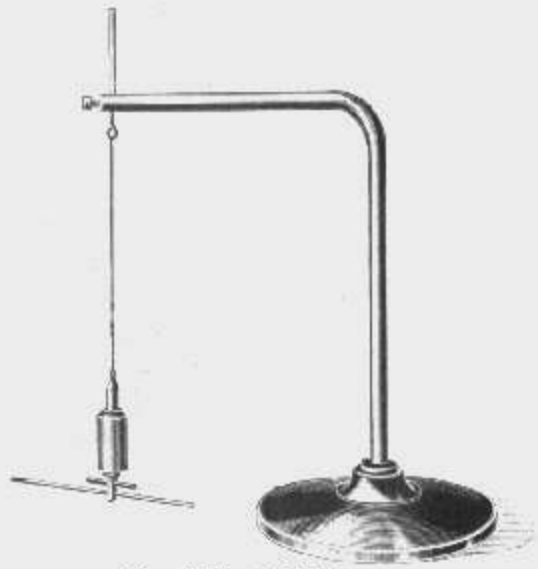
1389. Do. Do. Method described in Ayrton's *Practical Electricity*, 1900 Edition, page 64. A soft iron ball is suspended by means of an Ayrton-Perry spring. The ball is attracted by the magnetism of the bar under test. The downward movement of the ball elongates the spring, causing the pointer to move over a divided circle. As illustrated.
£3. 0s. 0d. $14.60 *d* *Clasplock*

1390. Pair of Bar Magnets, 330 × 25 × 6 mm., in box with keepers.
£1. 0s. 0d. $4.90 *d* *Claudicant*

1391. Robison Ball-ended Magnets, 15 cm. long, for demonstrating the positions of the magnetic poles. ... ... **3s. 6d.** $0.85 *d* *Clavier*



No. 1391. ½ full size.

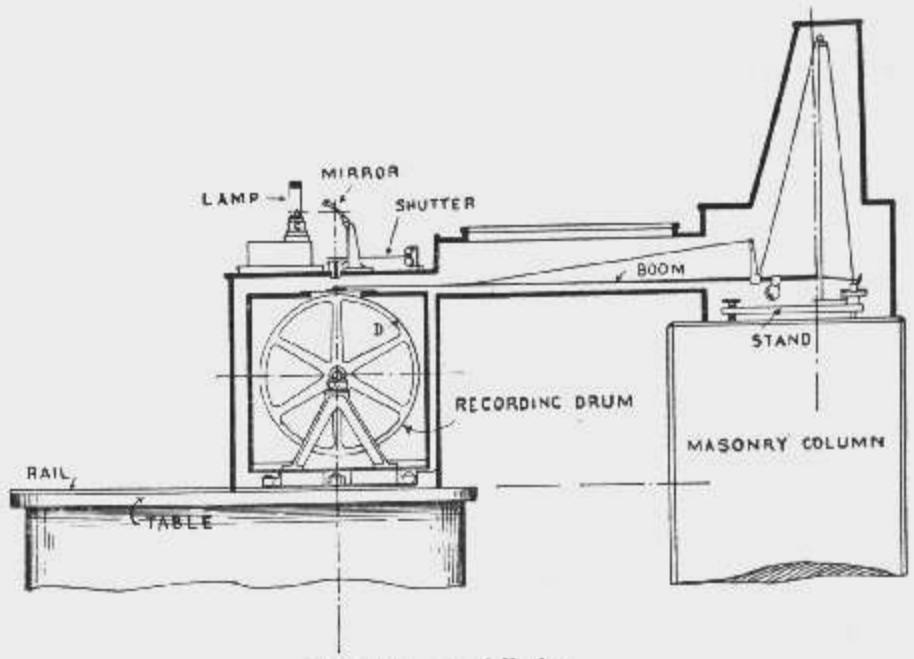


No. 1392. ½ full size.

1392. Suspended Magnet for plotting magnetic fields, or for use as a magnetometer. The magnet with aluminium pointer is suspended by means of a silk fibre from a brass stand. (See illustration.) ... ... **6s. 6d.** $1.60 *c* *Claystate*

§ 10. SEISMOGRAPHS.

1393. Milne's Horizontal Pendulum Seismograph (see illustration). This is the standard instrument used in the world-wide co-operative scheme of seismological observation. It is very sensitive to slight tilts, and can be readily adjusted to show a deviation of 1 mm. on the record for a tilt of 0·5 second. On the other hand it is not disturbed by the tremors due to ordinary traffic, and is therefore available for observations in a town.



No. 1393. ¼ full size.

The instrument comprises a light brass cylinder, D, 1 metre in circumference and 160 millimetres wide, mounted upon a steel spindle. One of the projecting ends of this spindle has a deep-threaded helix of 6 millimetres pitch cut in it; this being suitably mounted upon roller bearings, advances the cylinder 6 millimetres for one turn in four hours, by a gear connection with a clock. The bromide paper carried on the cylinder is changed every 3·5 or 4 days.

A cylindrical mirror has been introduced to give a concentration of the light on to the boom-plate.

For the time record mark upon the bromide paper, a shutter actuated by an electro-magnet is employed, the light being shut off from seven to ten seconds every hour. For this purpose a regulating clock with suitable electric contacts is required.

The advantages of the new arrangements are:—

1. A very open time-scale, with small consumption of paper.
2. On the open diagram obtained, wave-periods can be measured.
3. Movements of small amplitude are easily recognised.
4. Records can be quickly inspected and are easily stored.

Price of the complete instrument, including six months' supply of Bromide Paper, Photographic Chemicals, and one 7-inch wide brush for developing.

£75. 0s. 0d. **$365.25** *a* *Locution*

Eight-Day Regulator Clock, Dead Beat Centre Seconds, 9-inch Dial, Wood Rod Pendulum, in Walnut case; the dial is fitted with Electric Contacts for actuating the light-shutter of the Milne Seismograph for recording time on the Seismograms hourly. The clock is fitted with the requisite terminals and wires, also a triple cell dry battery in walnut case with terminals. Spare gut lines are provided for clock and a spare suspension spring for the pendulum.

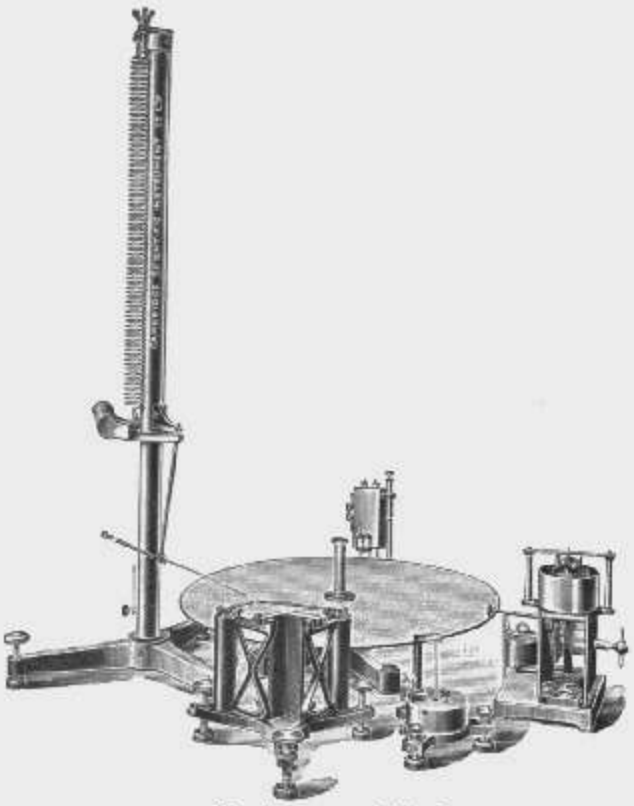
Complete. ... ... **£23. 10s. 0d.** **$114.45** *a* *Lodgeable*

1394. Ewing's Horizontal and Vertical Motion Seismograph. This instrument was originally designed by Dr Ewing, F.R.S., for the Seismological Observatory of the University of

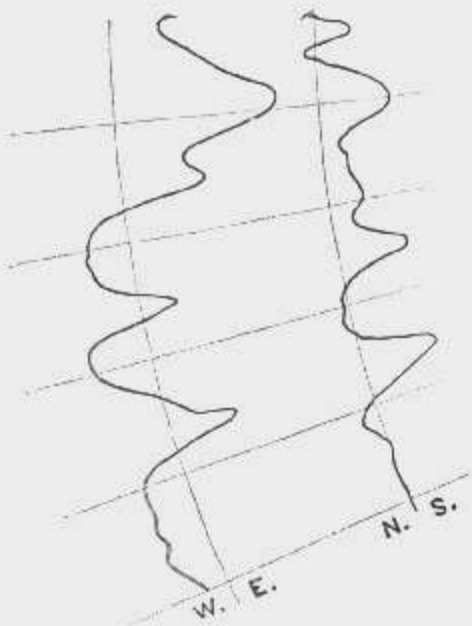
Tokyo, Japan, and is sensitive to short-period tremors. The apparatus illustrated records two rectangular horizontal components and one vertical component of each successive displacement of the ground. The records are taken on a revolving plate of smoked glass, which can be removed and replaced without disturbing the rest of the apparatus. A delicate seismoscope starts the plate moving at the commencement of the shock, and also starts a clock which makes a mark every second upon the plate. Two spare plates are supplied with the instrument.

The engraving gives a small part of a record of an actual earthquake taken by the two horizontal pendulums; the radial straight lines represent seconds of time.

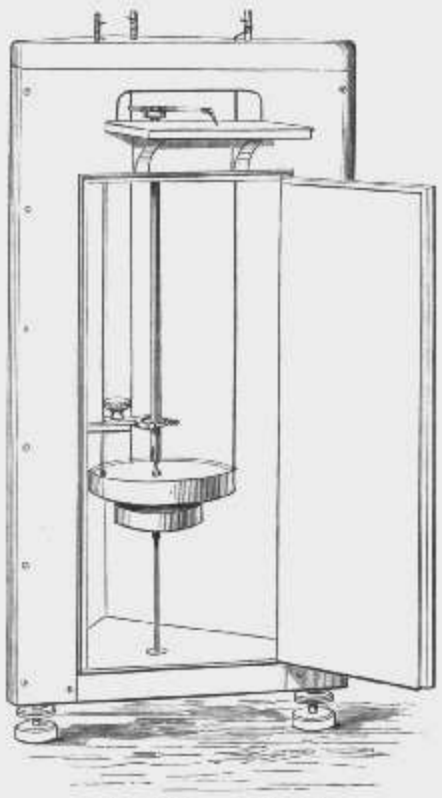
Complete apparatus as illustrated. ... **£75. 0s. 0d.** **$365.25** *c* *Cyanogen*



No. 1394. $\frac{1}{12}$ full size.



Record, about $\frac{2}{3}$ full size.



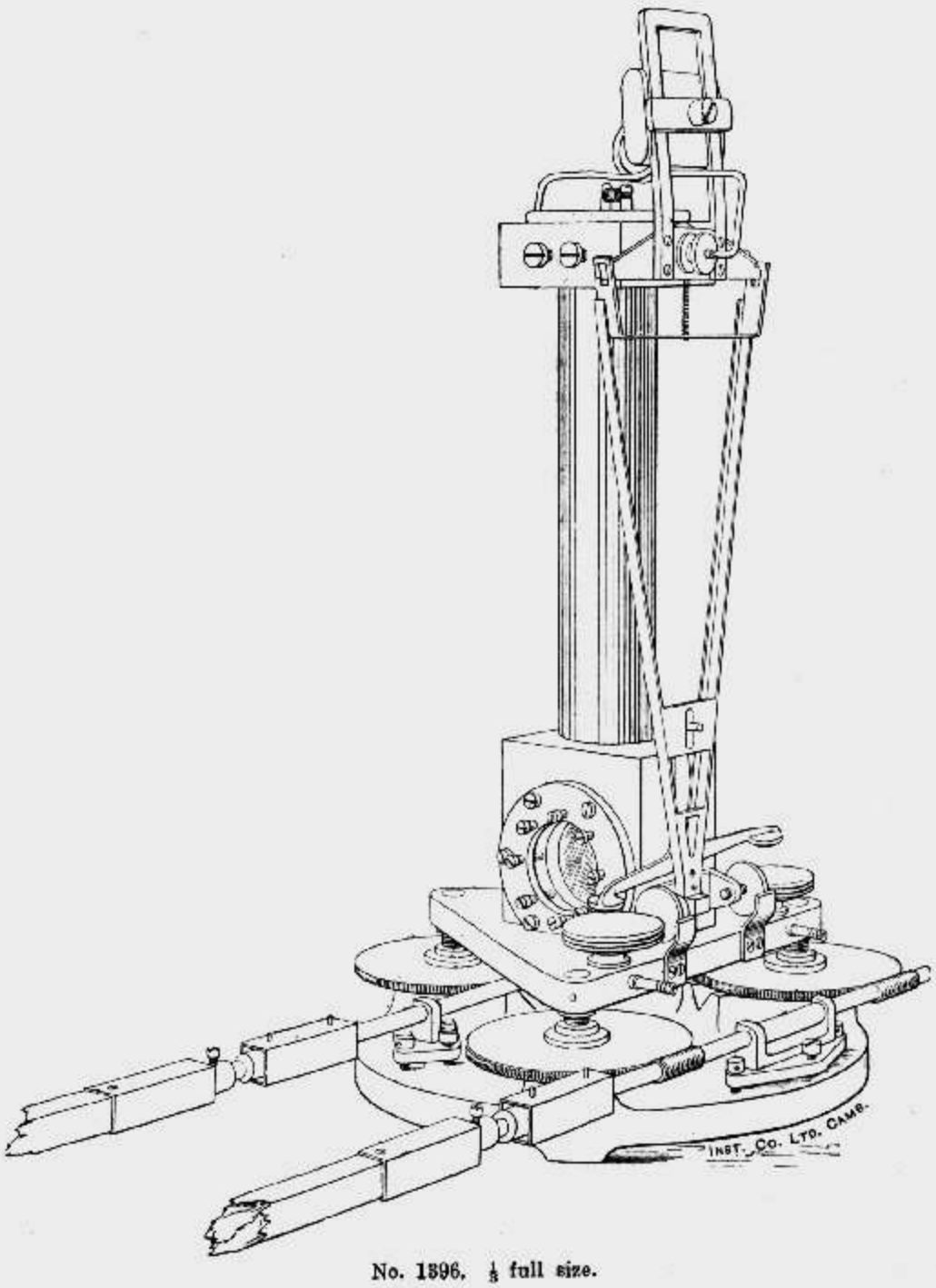
No. 1395. $\frac{1}{8}$ full size.

1395. Ewing's Duplex Pendulum Seismograph. This is an instrument for registering, on a fixed plate of smoked glass, and with suitable magnification, the whole horizontal motion of the ground. A bob consisting of a massive disc, hung by three parallel wires from fixed supports, is geared by a ball and tube joint to an inverted pendulum pivoted in a hard steel cup in the base of the instrument. The two bobs are proportioned so that the combination swings, in any azimuth, in nearly neutral equilibrium. A recording lever is carried by a gimbal joint above the hanging bob: its short end gears into the bob by a ball and tube joint; its long end carries a pointer which traces a magnified record of the motion on a fixed plate. The degree of stability of the combination is adjusted by raising or lowering the upper bob.

£14. 0s. 0d. **$68.20** *c* *Forgeman*

1396. Bifilar Pendulum. This instrument was designed for observing and recording slow tilts and pulsations of the earth's crust, by whatever cause they may be produced. It is possible to observe with this pendulum a tilt of less than $\frac{1}{300}$ of a second, an angle less than that subtended by a line an inch long placed at a distance of a thousand miles (see illustration).

£45. 0s. 0d. **$219.15** *c* *Cycloptic*



No. 1396. $\frac{1}{8}$ full size.

1397. Photographic Recording Apparatus for use with the above, complete with lamp.
£35. 0s. 0d. $170.50 *c* *Cymar*

1398. Railway Vibrograph, for continuously recording the vibrations of locomotives and rolling stock, arising from defects in the permanent way, or from imperfect balancing of the engine. Three records are drawn side by side upon a single sheet of paper, corresponding respectively to fore-and-aft, lateral and vertical motion, both the amplitude and the frequency of any vibration being clearly shown. ... ... **£50. 0s. 0d. $243.50** *b* *Lixivial*

§ 11. A FEW EXAMPLES OF APPARATUS MADE TO MEET SPECIAL REQUIREMENTS.

1399. Subsidence Apparatus. For investigating from month to month the slow subsidence of a building, or the progress of a geological fault. The essential part of the apparatus is a trough filled with oil or water, the upper surface of which is free. If the temperature of the liquid is approximately uniform, the surface of the liquid is level. A special micrometer can be geometrically seated on slabs firmly built into the wall above the trough; the micrometer screw is then advanced until its point just makes contact with the liquid surface, and the micrometer reading taken at all the slabs. If a similar set of observations is taken at a later date, it is evident that the relative vertical movement of the slabs can be determined. As an example, four slabs may be fixed at points which lie approximately in a straight line, the two middle slabs being fairly close together and on either side of a crack in a building. The readings logged from time to time can then be suitably combined so as to discriminate between the development of a shear, and a general tilting of the building as a whole.

Apparatus of this type has been fitted in a Cathedral, and has been under observation for some years. An attempt is also being made to measure the movement at a geological fault with similar apparatus.

1400. Spectroscopes. Of the special spectroscopes which we have from time to time constructed, one of the most notable was that supplied to the Astronomer Royal, Cape of Good Hope, for attachment to the 24-inch Refractor of the Royal Observatory. The Spectrograph contains four prisms whose temperature can be maintained constant night and day within a few hundredths of one degree Centigrade by means of a special Electric Thermostat. Sir David Gill's well-known recent work on the Radial Velocity of Stars has been carried out by means of this instrument.

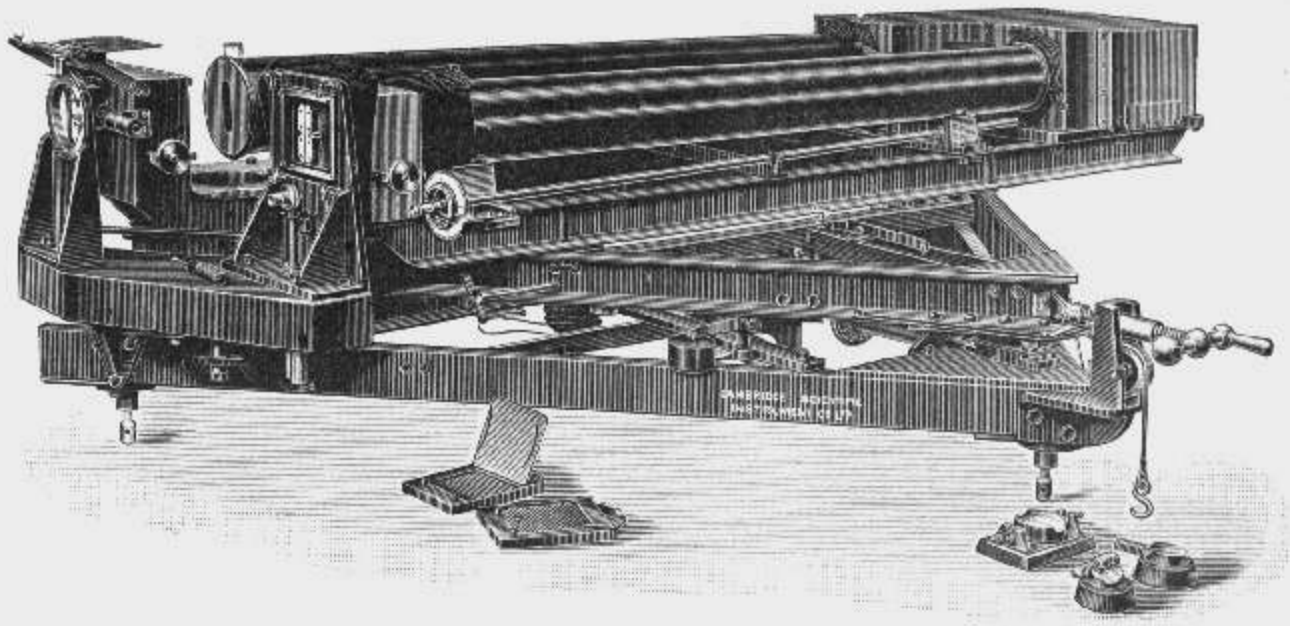
1401. Spectroheliograph for the Solar Physics Observatory, Kodaikanal, South India (see illustration). This instrument embodies the well-known Janssen principle of monochromatic photography of the sun's disc. By means of a siderostat the solar beam is directed upon a 30 cm. Cooke's photo-visual objective of 6 metres focus, which gives a primary solar image of about 5·5 cm. diameter. The primary image is focussed in the plane of a primary slit, and the light which passes the slit is rendered parallel by an objective lens, and dispersed by means of two flint glass prisms of 60° angle, the height of the prisms being about 10 cms. and the base of each an equilateral triangle of about 15 cms. side. The dispersed beam is bent back parallel to its original direction by means of a plane mirror, a second objective of the same focal length as the first being employed to bring the beam once more to a focus. When it is desired to work with higher dispersion than can be obtained by means of the two prisms, the plane mirror already referred to is replaced by a plane grating.

All the adjustments of the instrument have micrometer readings and are accessible from one position.

A special feature is the mechanism employed to impart a uniform motion to the spectroscopic train. To secure this result the whole train is mounted on a rigid iron frame-work which is supported by three steel balls upon which it can roll, a guide being provided to limit the freedom of motion to a single translation. To control the rate at which the frame is allowed to move

under the action of a suspended weight, a cylinder filled with oil is employed, the movement of the frame causing a plunger to enter the cylinder and expel the oil from it. The controlling valve can be adjusted and read micrometrically, and the exposure thus varied from a few seconds to more than an hour. The motion is perfectly smooth and free from all such irregularities as are almost inseparable from any form of toothed gearing.

A similar traversing motion has been supplied to the Solar Physics Observatories at South Kensington and at Mount Wilson, California.



No. 1401. $\frac{1}{12}$ full size.

1402. Kite Winding Gear. We recently supplied to Mr C. J. P. Cave of Petersfield, Hants., a kite winding gear driven by a 4 H.P. petrol engine, the apparatus being made in accordance with the general design of Mr W. H. Dines. Provision is made for paying out seven miles of steel wire from the winding drum, and under favourable circumstances a height of two miles is obtained by the kite.

1403. Osmotic Pressure. We have supplied to the Earl of Berkeley apparatus for his work on the direct measurement of osmotic pressure; including a screw-actuated pump for steadily maintaining high pressures, an absolute pressure-gauge for the determination of pressures by measurement of the load applied to an unpacked plunger, and various auxiliary apparatus.

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